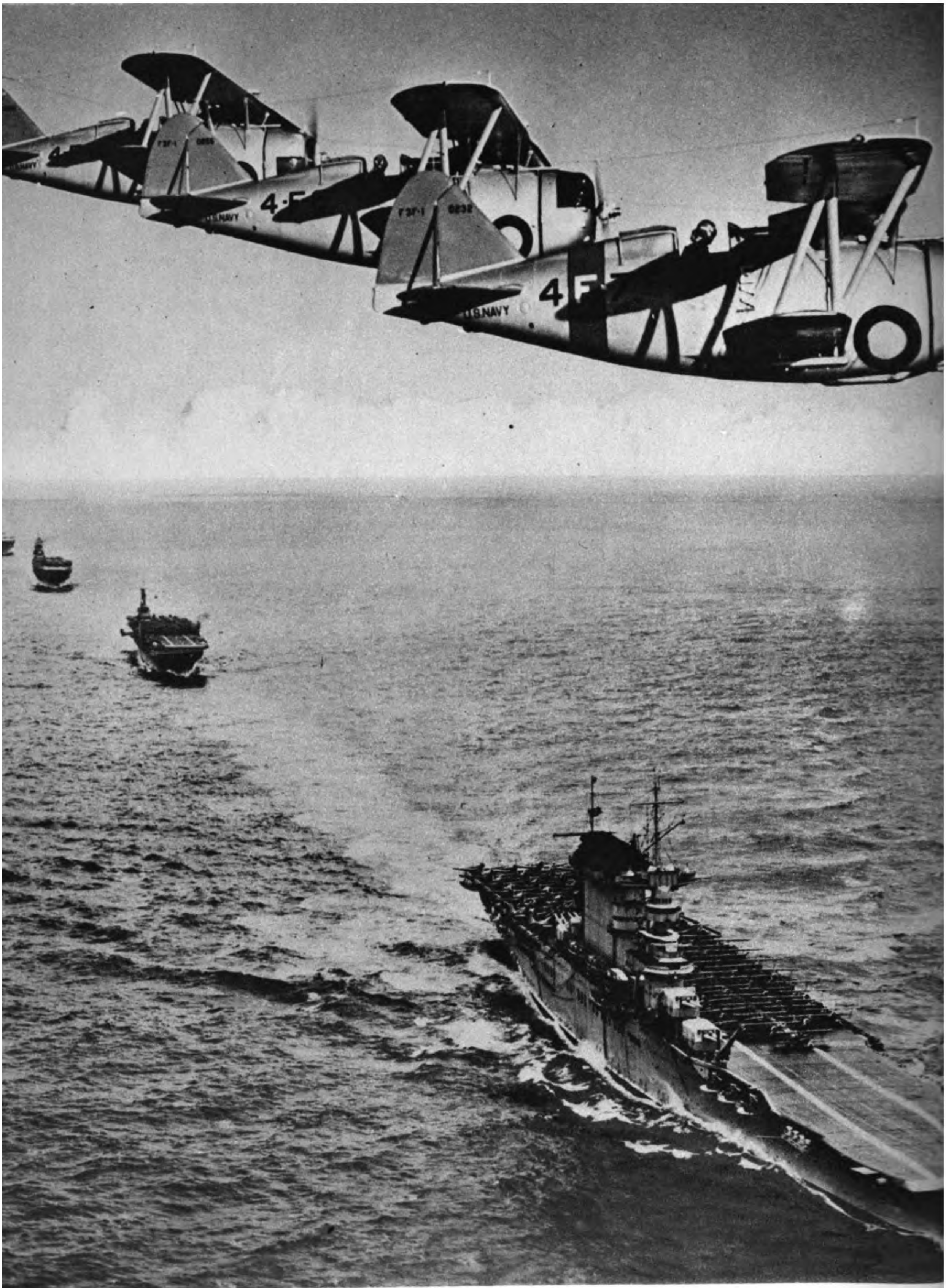
Flying Fleets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U.S.NAVY

FLYING FLEETS

A Graphic History of U.S. Naval Aviation

S. Paul Johnston

DUELL, SLOAN AND PEARCE
NEW YORK

first edition

All opinions expressed in this book are those of the author and in no way reflect the attitude of any government service or agency toward any of the subject matter involved.

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FOR MARY CAROL

Flying Fleets

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Flying Fleets

INTRODUCTION

Two dates stand out well above water in U.S. naval history.

On an early spring afternoon in 1862 a clumsy turtle-backed vessel poked her nose into Hampton Roads and proceeded to knock the spots off the pride of the Union Fleet. In little less than an hour the wooden frigates *Congress* and *Cumberland* lay on the bottom, and three other ships-of-the-line were on the beach. The Confederate ironclad *Merrimac* slipped back to her base with only a few dents in her sides. She was prevented from continuing the performance next day only by the timely arrival of Ericsson's much derided "cheese box on a raft"—the Union ironclad *Monitor*. Their three hour swapping of punches ended in a draw, but it also ended an era. The day of wooden ships was over. *On March 8, 1862, our modern Navy was born.*

On February 17, 1911, that same Navy sprouted wings. In a lather of spray and with a terrific racket from open exhausts, a box-kite of an airplane on a crude float wallowed away from a sandy beach outside of San Diego and took to the air. Glenn Curtiss, designer, builder, and pilot, was off to pay his respects to the Skipper of the *U.S.S. Pennsylvania* anchored in the harbor. For the first time an airplane took off the water, landed by a battleship, and was hoisted aboard. An hour later he was safely back in his North Island base. That day Curtiss put on a show that was to have a profound effect on the course of naval history.

An airplane on floats was something that seagoing people could understand. The apathy that the Navy Department had shown toward the airplane up to that time began to disappear. Officers who witnessed the tests became enthusiastic and even some of the

top-side people in Washington began to see some possibilities in the airplane as a useful naval auxiliary. Other tests had preceded the demonstration of February 17th, including Eugene Ely's deck take-off and landing, but Curtiss clinched the deal with his "hydro." From that day to this the Navy has been increasingly aviation-minded.

In 1911 to fly anywhere was newsworthy. The Ely and Curtiss flights to and from battleships made headlines all over the world. Now, scouts and fighters are catapulted from cruisers and take-off carrier decks hundreds of times a day in all kinds of weather, and nobody bats an eye. Whole squadrons fly non-stop in formation for thousands of miles with but scant mention in the public prints. Aviation has become an indispensable and accepted part of every Navy in the world.

From "Old Ironsides" down to the latest high-speed turbo-electric cruiser, the history of our surface Navy covers some hundred and sixty years. Only thirty years have gone by, however, since Curtiss paid his duty call on the Skipper of the *Pennsylvania*. But in those three decades, the men of our Flying Fleets have developed a tradition that matches that of their seagoing comrades. In those thirty years is a story of which all Americans may well be proud.

The purpose of this book is to present in condensed and graphic form something of that development and of the many-sided activities of our Flying Fleets and the men who pilot and service them. Little space will be devoted here to background material. The story of the development of the airplane and the airship has been told in a preceding volume—*Horizons Unlimited—a Graphic History of Aviation*. For those interested in going more deeply into the subject most libraries are full of books on the many special branches of the art.

This book deals entirely with aviation activities in the U.S. Navy. The U.S. Army Air Corps plays an equally important role in the preservation of the fence lines that encircle areas vital to

U.S. interests in the Western Hemisphere. Neither could do its job without the other. The closest possible co-operation and co-ordination exists between the tactical and technical branches of the two Services. Through such agencies as the joint Army-Navy Board, the Aircraft Section of the Office of Production Management, and the National Advisory Committee for Aeronautics, each Service has access to the latest developments in aircraft, engines and equipment. The story of aviation in the U.S. Army will be told in a succeeding volume—*Flying Fortresses—a Graphic History of the U.S. Army Air Corps.*

It goes without saying that no book of this sort could be written without the co-operation of the Bureau of Aeronautics of the U.S. Navy. To Joy Bright Hancock, through whose good offices much of the material was obtained, and whose suggestions and criticism were always very much to the point, more than a passing word of thanks. A bow also to all those manufacturers of airplanes and engines who opened up their files to make available photographs and historical material. Several other organizations contributed generously, among them, the National Advisory Committee for Aeronautics, the Institute of Aeronautical Sciences, Aeronautical Chamber of Commerce, and *Aviation Magazine.*

Ethel Greenburg kept an avalanche of pictures and miscellaneous material in check during the writing, and turned a finished manuscript out of a welter of notes, memorandums and intermediate drafts.

S. PAUL JOHNSTON

Washington, D. C.

Flying Fleets

THEIR MISSION AND MAKE-UP

Flying Fleets

THEIR MISSION AND MAKE-UP

BACK in the days of John Paul Jones, the Navy's job was comparatively simple. Our coastal lines were short. Sea-lanes important to us were not extensive. A string of wooden frigates scattered along the eastern seaboard sufficed to guarantee the integrity of our shores and to maintain for our commerce the freedom of the seas.

For a hundred years our naval problem changed only in degree. Our coast lines were lengthened considerably, and the scope of our seagoing commerce became world wide. Sail gave way to steam, wood to steel, but the strategic and tactical problems that faced Admiral Dewey in 1898 were essentially the same as those of Captain Paul in 1778. We simply built enough of the right kinds of battleship and cruiser to keep up with requirements.

But an event took place in mid-December of 1903 that changed all that. Man learned to fly. Very soon he had learned to fly well enough and far enough so that fortresses ashore and fleets at sea were no longer barriers to the coming and going of an enemy. In less than 40 years after the invention of the airplane, fleets of heavy bombers and swift fighters were in existence that could range for thousands of miles with tons of bombs on board. Theaters of war were no longer restricted to predetermined areas at sea and on land. Nations discovered the futility of Maginot lines. The theory that the nation that ruled the seas ruled the world became suspect. England found that the Channel was no longer a fence, and that the Royal Navy was no great protection against an invader from the skies. Almost too

late perhaps she came to realize that her real frontiers were not on the Channel, but on the Rhine.

We too are learning our lesson. Fortunately, we are learning it by example and not from bitter experience. We know now that we cannot expect to defend ourselves by erecting fences along our seacoasts. If an enemy comes even within sight of our shores we are already too late, our first lines of defense have been broken—we have already been invaded. By that time, hostile aircraft launched from carriers at sea or from bases on the American continents, would be pounding at the heart of our industrial areas. Our real frontiers lie many miles off-shore. It is the Navy's job to see that they stay there.

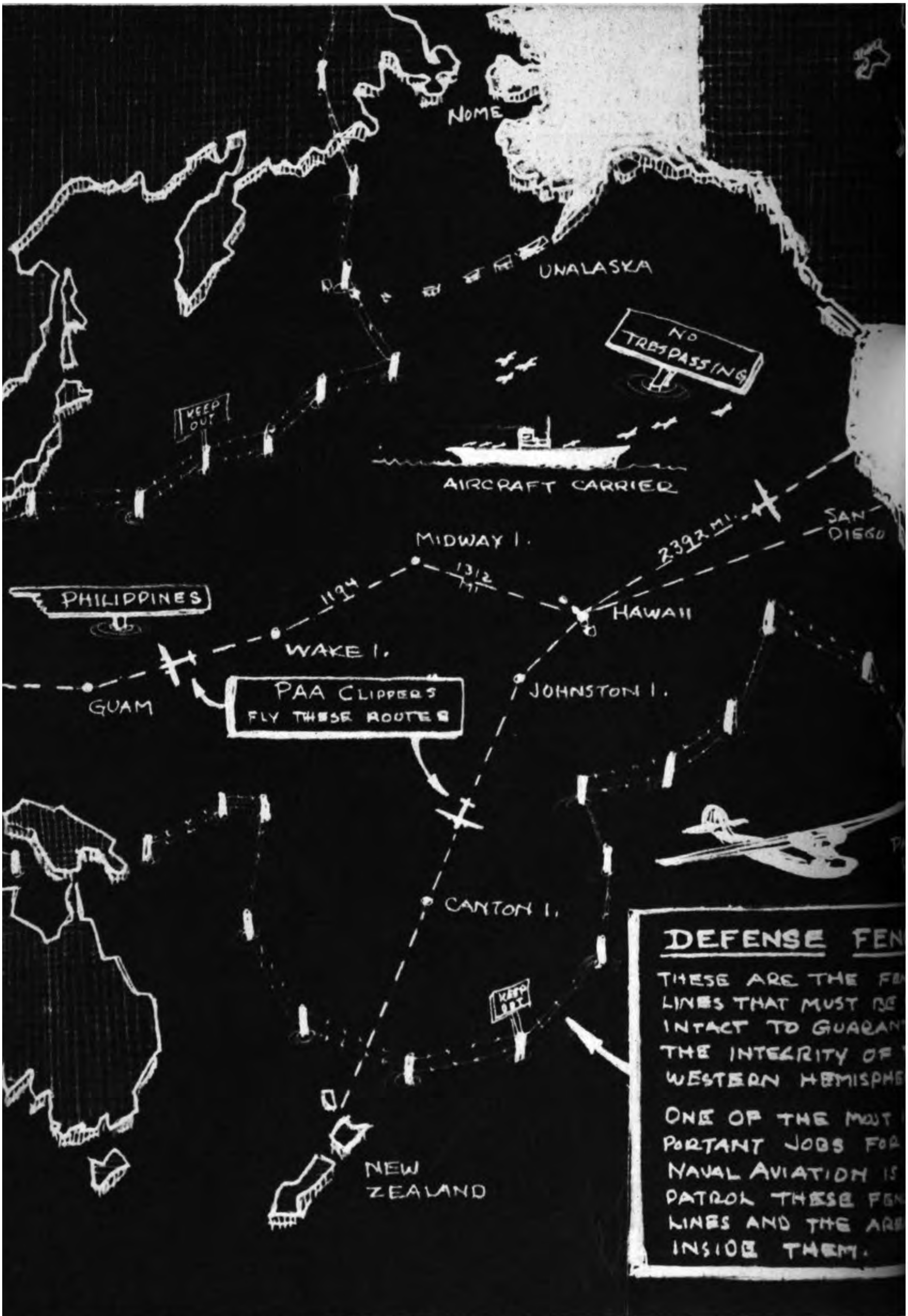
But if the airplane has forced such extension of our lines of defense, the airplane also has made it easier to maintain them. Vast areas of ocean can be patrolled from strategically located bases on the fringes of our vital areas. Enemy movements can be scouted out long before they develop, and enemy fleets attempting to penetrate our defense lines can be greeted by concentrations of bombers. Aviation has become a necessary and an integral part of our Navy. Fleets that fly have changed the entire defensive strategy of the United States.

Battle fleets afloat or aloft cannot be self-sustaining for indefinite periods. Battleships and cruisers may stay at sea for weeks or months, but sooner or later they must put in at shore bases for fuel, for ammunition, and for supplies. Aircraft require attention at much shorter intervals, a matter of hours—or of a couple of days at most. Hence the importance of bases at such points as Unalaska, Hawaii, Guam, British Guiana, Bermuda, and Newfoundland. Until recently many of these points were not available for our use. There were gaps in our fence lines, particularly in the Caribbean area. Our recent agreements with Great Britain, however, have opened up to us the bases that we need to permit long range naval aircraft to keep our fences in order.

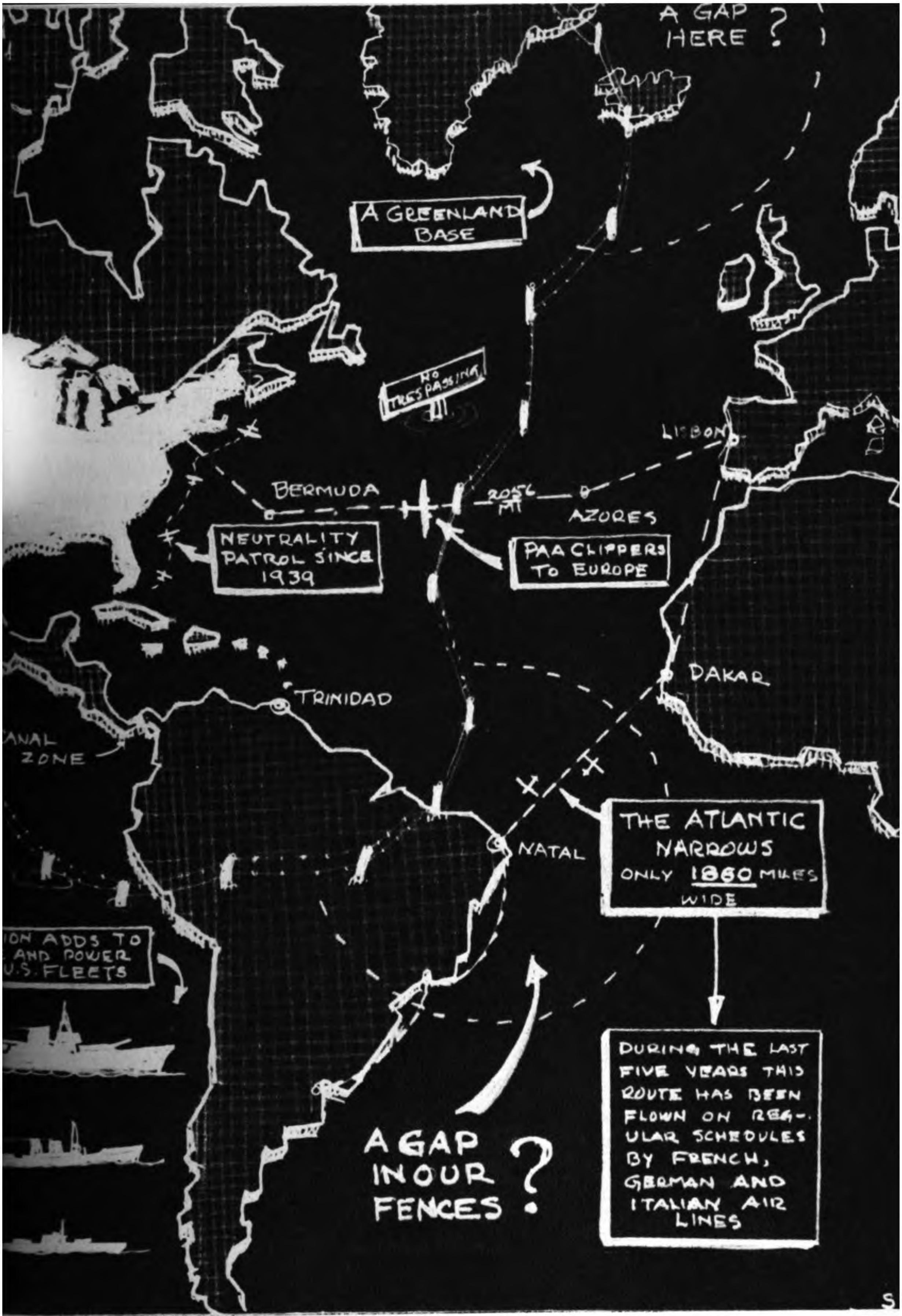
There has been much loose talk about the range of operation

of modern aircraft. It is true that large bombers and huge flying boats are being designed and built to operate non-stop with military loads for six or seven thousand miles, but for a long time to come these will be the exception rather than the rule in anybody's air force. Effective radii of action for air attack and defense are much shorter, but they average better than a thousand miles. Our naval patrol squadrons are now supplied with large numbers of patrol aircraft that can easily fly well over three or four thousand miles non-stop. Their effective radius of action is, however, somewhat less than half their extreme range. If they are to perform useful missions they must be able to do a considerable amount of cruising far out at sea and must also have enough reserve fuel so that there will not be any question about getting back to base. Taking such factors into account, it seems reasonable to assign an arbitrary limit of about 1,500 miles for a practical operating range for modern flying fleets. The accompanying map has been drawn up on this basis. It shows the fence lines over a thousand miles off-shore which must be patrolled by our naval aviation.

The weakest link in the chain lies to the south and east of the Caribbean, beyond the area that can be covered from Trinidad or Georgetown—where South America and Africa are less than 2,000 miles apart. For several years a number of European countries have been flying mails and freight on regular schedule between Dakar in Africa and Natal in Brazil. Hundreds of flights have been made across the South Atlantic in all kinds of weather. Plenty of experience has been accumulated in that area which might easily be turned to military account. In order to protect ourselves at this point, and primarily to prevent any European power securing a foothold in the northeastern tip of South America, it would seem necessary to establish another base farther east, either at Para or at Natal itself. From such a point our shore-based aircraft could sweep the entire "Atlantic Narrows" without difficulty.



A JOB FOR THE *Flying Fleets*



This map shows areas vital to Western Hemisphere defense that must be patrolled by shore- and ship-based aircraft. Radii of action used to lay out the fence lines are approximately fifteen hundred miles.

The map explains why the Navy has gone in for big seaworthy long range flying boats. Our current and projected designs are the most efficient in the world. Planes like the two-engined Consolidated PBY's and the Martin PB2M's will shortly be supplemented by larger four-engined Vought-Sikorsky, Martin, and Consolidated airplanes—battleships of the air, easily capable of patrolling fences thousands of miles off-shore in any weather, carrying guns enough for their own protection and packing away in their bomb-bays missiles large enough to sink battleships. A few such planes are now in service, hundreds more are on order.

At one time it was believed that the large rigid airship of the Zeppelin type was the ideal craft for long range scouting and patrol. Ten years' experience with big rigid airships proved disappointing, and at the moment, the Navy has put most of its plans for very large airships on the shelf. There is, however, a new program for lighter-than-air, for smaller airships of the nonrigid type. They are to be spotted at strategic points around the rim from Newfoundland to Alaska, where they will be used principally for anti-submarine and convoy duties.

But the job of "riding fence" around areas vital to United States interests is only one of the jobs for the fleets that fly. It is only one of the elements of naval aviation's major mission—to increase the effective striking power of our fleets.

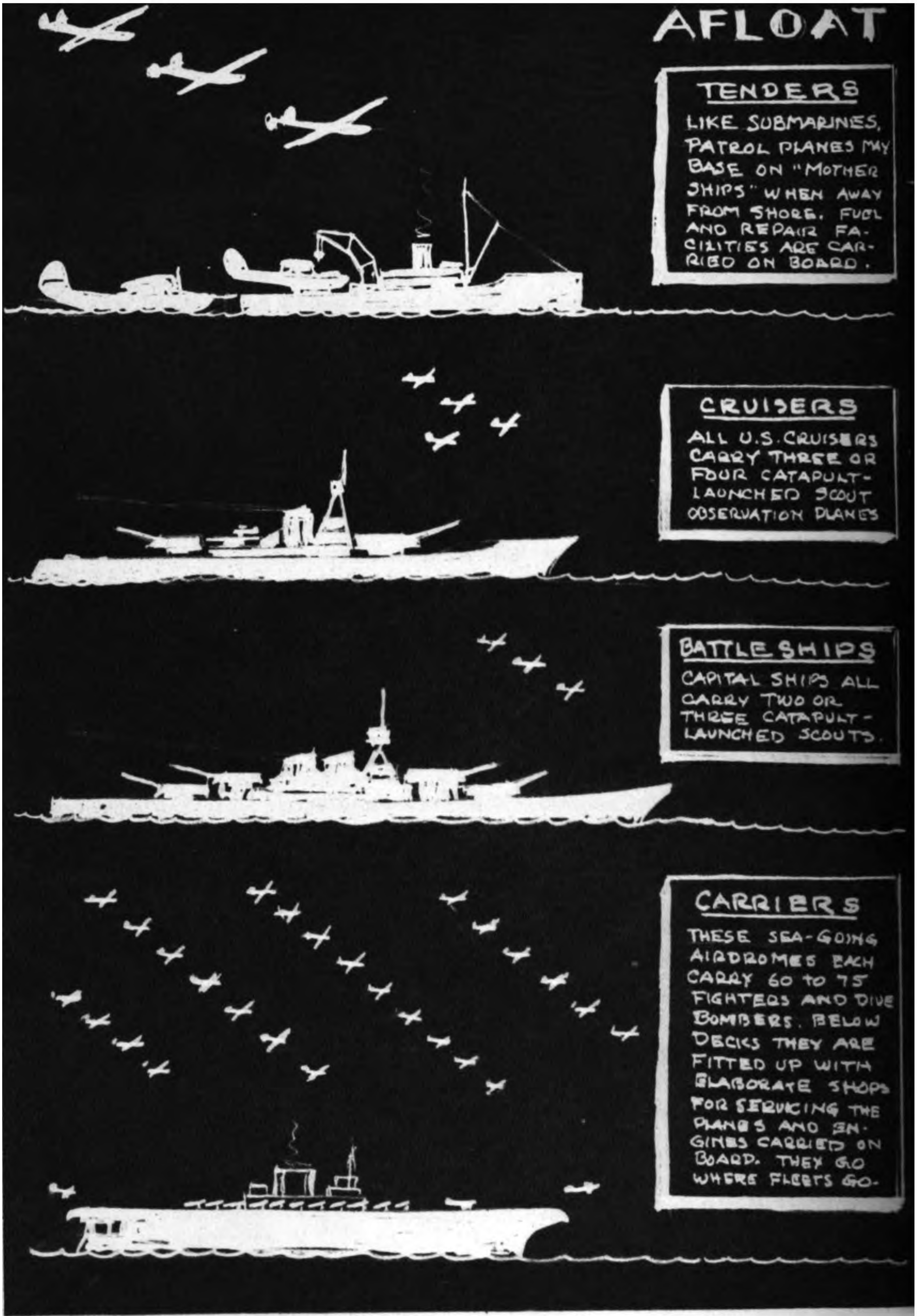
To help the battle fleets most effectively, naval planes and pilots must be able to go to sea with them. They must operate whenever and wherever battleships operate, under all sorts of conditions from the Tropics to the Poles. No small assignment this! Only 30 years ago pilots stayed on the ground if more than a breath of air was stirring. They seldom dared get out of sight of land, or fly where they could not see the ground. Today it is routine to launch fighters and scouts in anything but a full gale at sea. Pilots fly blind for hours in fog and rain and ice searching out objectives hundreds of miles under horizons, returning to their ships without difficulty.

To protect surface vessels against attack by enemy bombers, fast heavily armed fighters must be available. These agile "destroyers" can fly rings around most bombers. Their concentrated fire power from quick-firing cannon and machine guns makes them the equal of any adversary. But because they are small and packed with power, they are limited in their field of action. Such aircraft would be of little use if restricted to operation from fixed bases. They must be able to go to sea with the fleets if they are to be of maximum value. The aircraft carrier provides the solution. These seagoing airports can keep up with the surface fleets. Their swift fighters can be sent up in swarms to beat off any attack against the battleships and cruisers of the fleet. Their dive bombers and torpedo planes can effectively attack enemy battleships far out at sea.

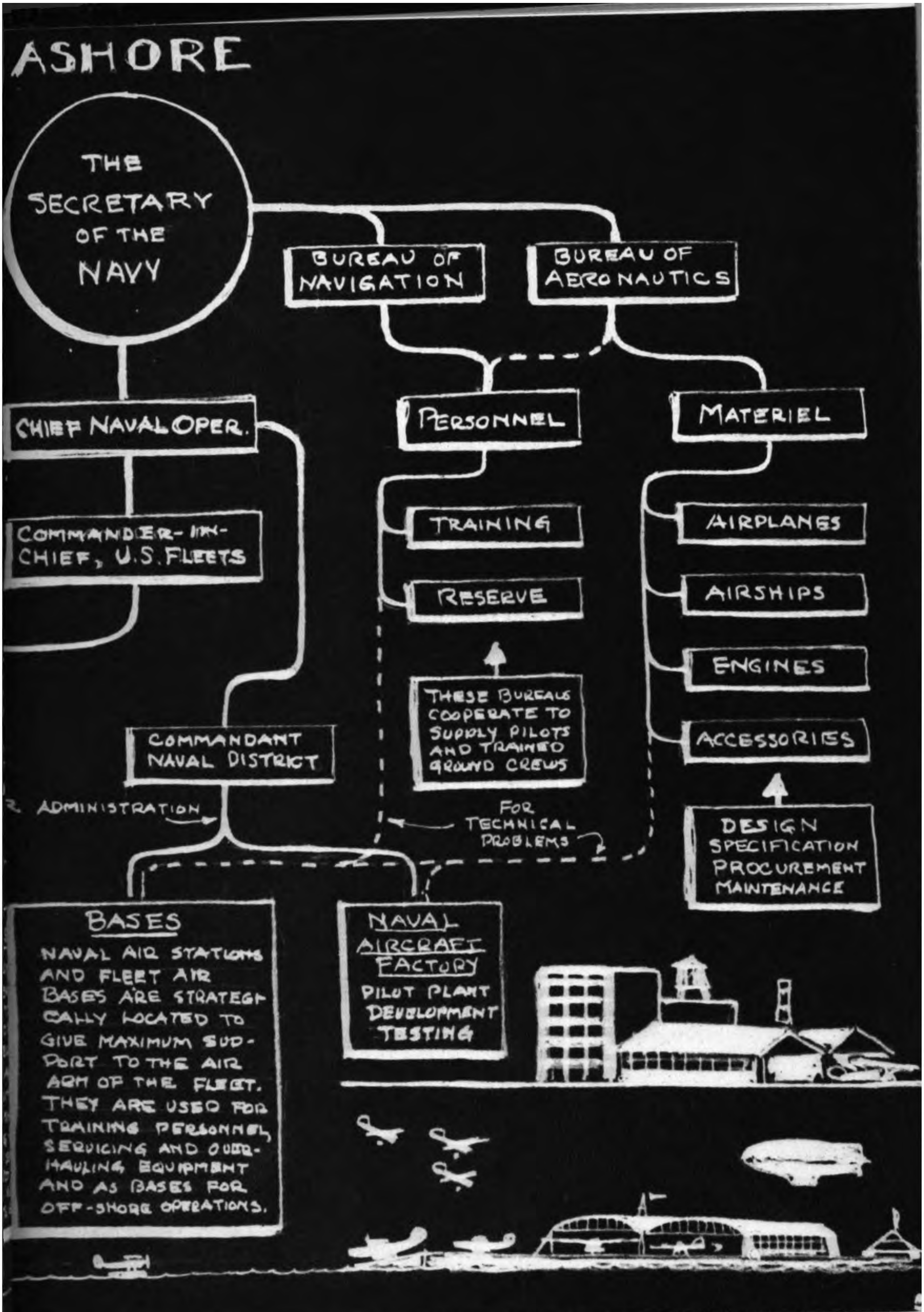
Until the seagoing airplane came along, a sailor's horizon was limited to what he could see from the topmast of his tallest ship. Possibly a dozen or so miles was the best he could hope for even under the most favorable circumstances. Enemy fleets forty or fifty miles away were out of sight as well as out of range. Today, however, horizons at sea have been tremendously extended. Scouting airplanes cruise for hundreds of miles around battle fleets, reporting their findings to commanding officers by radio. And once surface fleets are in contact, high-flying observation planes report hits and misses to gunners who are firing at targets far beyond their range of actual vision.

Every U.S. cruiser and battleship carries from two to four airplanes for scouting, range-finding, and general observation. These are usually two-place seaplanes launched from catapults carried on board. Returning to their ships, they land in the water alongside and are taken back aboard by cranes. They are generally armed for defense only, and are fitted out with elaborate equipment for photography and communication.

Besides its patrol bombers, fighters, torpedo carriers, and scouts, the Navy also carries on its rosters many utility types—cargo car-



ORGANIZATION PATTERN FOR *U.S. Flying Fleet*



Neither detailed organization chart nor complete functional diagram—but a tabloid view of what makes U.S. Naval Aviation tick.

riers to transport needed parts and equipment between shore bases, amphibians to shuttle matériel and personnel from ship to shore or shore to ship.

Such an array of tactical and transport aircraft cannot be handled by amateurs. Each pilot of our Flying Fleets must be an expert flyer and a specialist in his particular branch. Hundreds of training airplanes are being provided at naval training stations to turn out pilots for the fleet. Trainers range from relatively simple low-powered planes good for elimination training only, up through fully armed tactical machines in all categories for advanced work.

Of such are the ships that make up the Flying Fleets of the U.S. Navy. Each has its own special mission, each is described in some detail in the pages immediately following.

THE U.S. NAVY'S *Flying Fleets*

are made up of seven basic types of aircraft. Each has its own designation which appears as a part of the type number painted on the rudder of every plane. Thus, F stands for *fighter*, B for *bomber* (sometimes TB for *torpedo bomber*, DB for *dive bomber*, SB for *scout bomber*), P for *patrol*, S for *scout* (sometimes combined with O for *observation*), J for *utility*, and N for *trainer*. There is also a code for manufacturer and model number (for example, C means Curtiss, D for Douglas, F for Grumman, M for Martin, U for United, and Y for Consolidated). An X in front of any series of letters indicates that the machine is still in the experimental stage. Thus, XSOC-3 would indicate an experimental scout observation machine of the third model to be built by the Curtiss Company.

Non-rigid airships in the Navy are designated by class, in alphabetical order. The first machines were of the A class. We are now up to classes K and L. For the larger airships Z meant Zeppelin type, R rigid. Actually, our rigid airships were seldom referred to by model number. They were all named, as are the battleships and cruisers of the Navy.

Today Z has come to stand for all lighter-than-air craft in the Navy, including balloons. The corresponding general symbol for heavier-than-air is V.

FIGHTERS

Night still shrouds the flight deck of the carrier, but top-side is abustle. Helmeted crews move with precision. Elevators rise and fall without stopping, each trip bringing up stubby fighters from the hangar deck. Wheeled quickly away, they are soon stacked so closely that men can scarcely move among them. A word from the bridge, a hundred starters grind into action, followed by the sputtering roar of a hundred motors. Loud-speakers blare. The order—"Pilots, man your planes!" echoes through the ship. Goggled, leather-jacketed figures pour from the ready-room. In scarcely a minute the leader of the first section roars off over the bow. Dawn is just breaking—another day's work beginning for the fighting pilots of our Flying Fleets. . . .

Curiously enough, all fighters in the U.S. Navy are land planes. Because they are designed to operate from aircraft carrier decks they are fitted with landing wheels rather than with the floats used for the scouts. They must be able to take-off and land in limited spaces. They get away unassisted, but efficient arresting gear permits safe landings in very restricted deck areas.

For a long time the Navy specified biplane types because they were more compact than most monoplanes and therefore more easily stowable on flight and hangar decks. But in the past few years stubby, short-span monoplanes have been designed that are as compact as biplanes, and give much better performance. For maximum speed and efficiency, their landing gears retract—no rivet heads protrude from smooth metal skin—and engine cowlings approximate pure streamline forms.

All Navy fighters today are single-seater, single-engined machines. Speeds are beginning to crowd 400 miles an hour. They are highly maneuverable and heavily armed with 30- and 50-caliber machine guns and with larger quick-firing cannon. Their vital spots are armored. Constant research and concentrated development keep our Navy's fighters up with the most formidable military aircraft in the world.

(Rudy Arnold, Courtesy Grumman Aircraft Engineering Corp.)

This is a Grumman F4F deck fighter

BOMBERS

Twelve thousand feet above the sea—hidden from below by a thick overcast, the dive bombers drill along, nose to tail, like a school of sharks on the hunt. Crews are tense. Their objective is close. Suddenly, through a hole in the clouds, a glimpse of enemy cruisers—black dots cutting broad vees in gray water. Squadron leaders waggle wings. One after another, plane after plane "peels off" formation, plummets down through the clouds in a snarling, screaming dive toward a target two miles below. . . .

Dive bombing was first developed by the U.S. Navy. Its purpose is to improve accuracy of bombing from small aircraft, and, at the same time, to reduce the probabilities of the bomber being destroyed by anti-aircraft fire or by fighter airplanes during an attack. Dive bomber pilots literally "ride" their own bombs down—aiming them by aiming the whole airplane at the target. At 500 m.p.h. it takes only 15 to 20 seconds to drop 12,000 feet. Bombs are released at the last possible instant, as close to the objective as possible, then the plane is pulled sharply out of the dive and makes its getaway.

Airplanes for dive bombing must be built very strongly to stand the strain of steep power diving and quick pull-out. They are generally armed with machine guns for defense only —their major wallop being packed in the bombs slung beneath the belly. They must be able to land and to take-off from carrier decks. Their wings are usually made so they may be folded when aboard ship to minimize stowage space.

Airplanes of similar type are used for torpedo carriers. The torpedos used are of the standard marine variety. They are carried externally, slung between the landing wheels, or between twin floats. In a torpedo attack pilots fly close to the water, dropping their missiles at point-blank range—then climb swiftly away to safety.

(*Official Photograph U.S. Navy*)

These are Douglas TBD-1's

PATROL

The beach at North Island is a beehive of activity. Big PBY's in long ranks stand high and awkward on their beaching gear, idling propellers cutting bright discs in the California sunshine, engines rumbling with pent-up power. Last good-bys—crews go aboard. One after another the big planes waddle down the ramps. Once afloat, bathing-suited crews release and retrieve the beaching gear. To a full throttle crescendo they taxi out into the bay and thunder into the blue sky. VP-16 is off for Hawaii, two thousand miles and fifteen hours away. . . .

Patrol planes must operate for long periods of time away from home. For weeks on end they may "base" on floating tenders—refueling and rearming in the open sea or in whatever sheltered spots are available. Reliability, seaworthiness and great range are the obvious requirements. Ability to carry heavy bomb loads and to protect themselves against attack are prime necessities.

Bulk of the Navy's patrol bombers today are twin-engined monoplane flying boats. Their engines are air-cooled, mounted in streamlined nacelles in the leading edges of wings (high enough above water so that the propellers run clear of any spray thrown up during taxiing or take-off). These boats are both seaworthy and airworthy. They weigh in the neighborhood of 20,000 pounds fully loaded, and have an effective range of over 3,000 miles at a good 150 m.p.h. Hundreds are now on hand—over a thousand are on order.

Latest developments are larger flying cruisers with four air-cooled engines, that weigh as much as 60,000 pounds and can fly non-stop for well over 5,000 miles.

But the Navy is not stopping there. Plans are drawn and construction under way on patrol bombers of close to 100,000 pounds gross. Ocean-going planes of 250,000 pounds' weight and 10,000 miles' range are not impractical nor impossible with present knowledge of airplane structures and power plants.

(*Official Photograph U.S. Navy*)

These are Consolidated PBY's

SCOUTS

A gaunt steel girder swings out slowly from the deck amidships. The catapult comes to rest, pointing the wind's eye. Inboard, clamped to a steel carriage, an airplane, with warmed-up engine ticking over idly. Pilot and observer secure their belts, make last minute checks. "All clear!" A rising roll of thunder beats against the cruiser's gray funnels. The plane shakes and vibrates from nose to tail. Pilots brace themselves hard against seat backs and headrests. A hand is raised—"Fire!" Wham—Swish—Bang!—Almost before the eye can follow or the ear recover from the combined roar of the "shot" and the racing engine, the plane is a hundred yards away and climbing steeply into the blue. . . .

Scout observation machines for the U.S. Navy are single-float seaplanes. They are "shot" from ships' decks, but they land on the water. They must be strongly built to stand the shock of catapulting and the strain of retrieving by crane. They must be compact for easy deck storage and rugged enough to withstand weather conditions encountered at sea. In peace or war they go where the ships to which they are assigned go. They are as integral parts of our battleships and cruisers as are the big guns in the turrets.

S and O class machines have two principal missions in the Navy, scouting for information on enemy fleet movements and observing and correcting gun-fire for battleships. They fly at about 150 m.p.h. and carry sufficient fuel to stay in the air for several hours.

Most of the scout observation types now in service are two-place biplanes powered with radial air-cooled engines. Lately, new design trends are in evidence. Experimental, short-span, cleaned-up monoplanes of considerably better performance have been tested and ordered in quantity. Some of these machines have been fitted with inverted in-line air-cooled engines, some with radial air-cooled types. The newest models fly at 250 m.p.h. or better.

(*Official Photograph U.S. Navy*)

These are Curtiss SOC-4's

UTILITIES

Radio signals crackle. Up the elevator to the carrier's flight deck comes an ungainly looking airplane—a flying boat on wheels, amphibious. Engines growl. It gathers speed slowly—takes to the air. Thirty minutes later, 80 miles away, wheels tucked up against hull sides, it alights on the water near a hove-to destroyer. A small boat puts off, brings out an injured seaman. Transfer is quickly effected. In a whirlwind of spray and foam the amphib gets quickly away, bee-lining for shore. Miles inland, on a broad airport, the plane lands—on its wheels again, to taxi to a waiting ambulance. . . .

Apart from its purely military functions, naval aviation does a multitude of other jobs. There may be coastlines or harbors to be surveyed or photographed. Scientific expeditions here and there may need a hand-up. At any time naval aviators may be called upon to undertake rescue work at sea or on land. It has become routine to transport personnel and supplies from coast to coast or from Alaska to the Zone.

For such miscellaneous usages the Navy keeps a number of utility types spotted about with the Fleet or at shore bases. Many of these planes are of the amphibian type. High speed and maximum maneuverability are not essential for such service, and it is useful to be able to land or to take-off at will from airport, from ship deck, from catapult, or from water.

But not all of the Navy utilities are amphibians. Officers and men must frequently be transported quickly over long distances and a number of transport planes, similar to those used on the airlines, are always on hand. They are not fitted out as luxuriously as the commercial transports because it may be necessary to take on board from time to time a miscellany of supplies and equipment. Spare engines and propellers are frequently needed in outlying stations, and the quickest and best way of getting them there is by air.

The utilities are the work-horses. They do not partake of the glamor of the combat types, but they serve a useful and necessary purpose with the Flying Fleets.

(*Official Photograph U.S. Navy*)

This is a Grumman J2F-2 amphibian

TRAINERS

High over Pensacola Bay a tiny two-seater points its nose skyward—zooms, hangs motionless for an instant, slips off into a sickening downward spiral. One—two—three times it spins—sun flashing on chrome-yellow wings. Smoothly and precisely it straightens out, coasts off in a long shallow glide, settles down to plow a white furrow in blue water. From the front seat a goggled instructor grins back at an anxious cadet. He raises a clenched fist, thumb up—"Well done!" Another cadet has finished with Squadron One—the first step toward winning wings. . . .

U.S. Navy trainers are of two types—land planes and seaplanes. Primary trainers are fore-and-aft two-seaters—biplanes of moderate power which may be operated from wheels or floats. Their purpose is to teach prospective pilots the rudiments of flight. They are the standard equipment for Squadrons One and Two at Pensacola. Simple in equipment and rugged in construction, they must take a lot of hard punishment without failure and with a minimum of maintenance. Most of them are built at the Naval Aircraft Factory at Philadelphia.

For more advanced work—simulated deck landings, gunnery, navigation formation flying, and the like—two-place, low wing monoplanes of reasonably high performance are used. In the interest of standardized production, the same types used by the Army Air Corps have been ordered by the Navy. These machines are fitted out with equipment of the same sort as is installed on tactical types for combat service.

For final instruction actual tactical types are used. They are usually machines that have been replaced in the Fleet by newer models. They include everything from carrier fighters to the big patrol boats.

Final stages of training are carried out in the Fleet on combat types. Cadet pilots take their places in regular squadrons on cruisers and carriers. They learn to fly off deck and catapult as consistently as off the runways at Pensacola. They are equally at home on the water and in the air. In due course they become the full-fledged pilots of our Flying Fleets.

(*Official Photograph U.S. Navy*)

These are Stearman NS-1 trainers

AIRSHIPS

Great hangar doors part and rumble open. Out of a shadowy interior slowly emerges a smooth silver snout—radial ribbed, softly distended. Tugging impatiently at a hundred restraining hands, the airship is guided out into the open, for all the world like a great Car of Juggernaut carried in procession on the shoulders of East Indian priests. Engines cough into life—run up to a full-throated roar, then smoothly idle. A sharp command—"Up Ship!"—and like a great fish swimming up from the bottom of the ocean of air it gets smoothly away. . . .

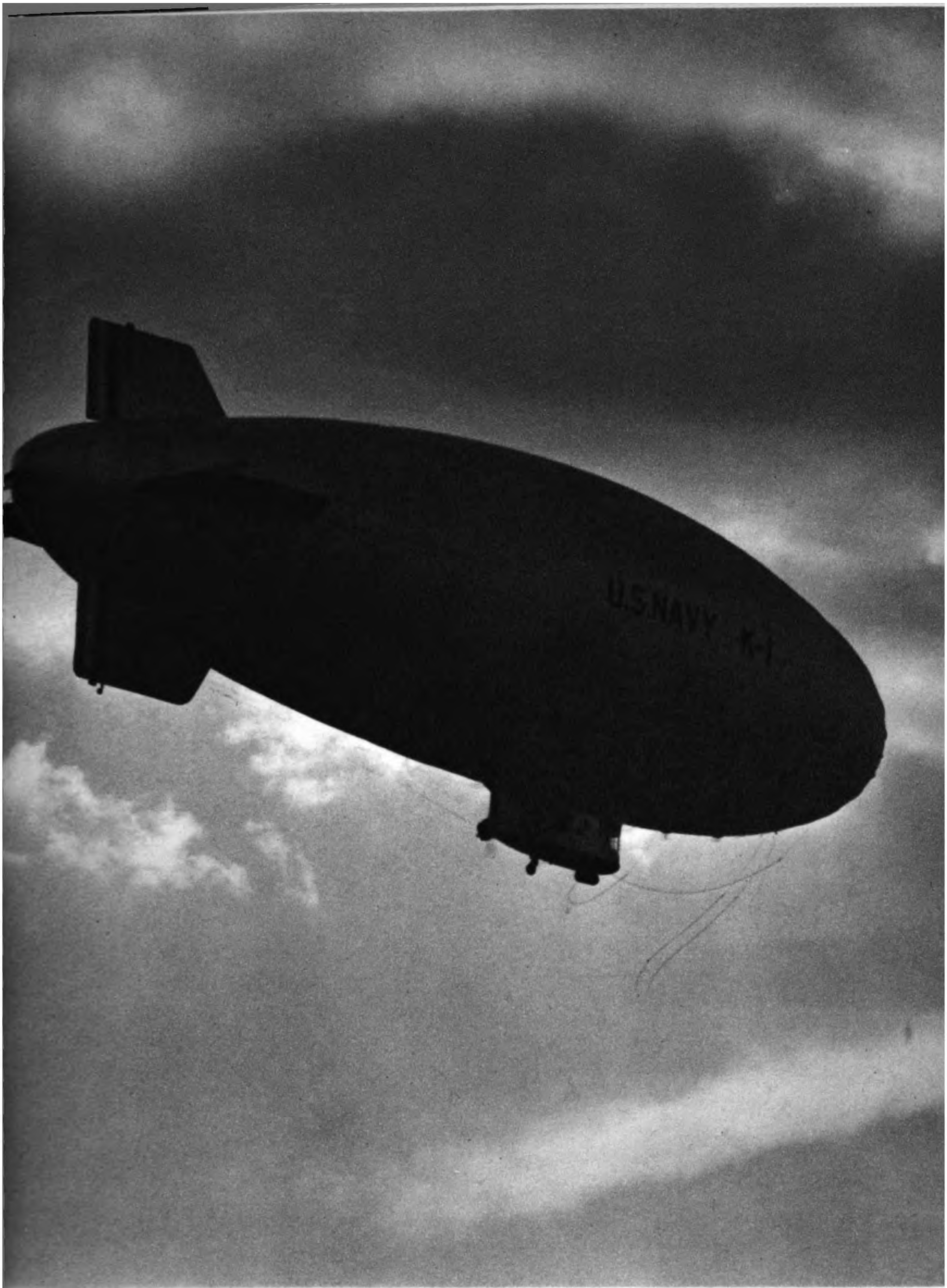
Naval airships today are all of the non-rigid or blimp class. The term "blimp" was coined during the first World War from the British terminology—"B" class *limp* (or non-rigid).

A non-rigid airship, in one respect, is similar to a free balloon—its shape depends entirely on the maintenance of gas pressure inside the envelope. If the gas escapes, the airship collapses completely. The car or cabin for pilots and crew is suspended directly from the bag.

Semi-rigids generally have a keel, or backbone, of some sort running from bow to stern to which the envelope is attached and which houses power plants, crew, and cargo.

A rigid airship holds its external shape, gas or no gas. The hull is made up of a light basket-like structure consisting of transverse rings and fore-and-aft stringers. Individual cells inside the framework contain the lifting gas. Some of the larger rigids had as many as 16 such cells. Any one of them could be deflated without affecting the others.

The airship's mission with the Navy is for coastal patrol, convoy work, and general scouting. Some of our rigid airships were also used as flying airplane carriers. They were fitted with a sort of trapeze device on which airplanes could be picked up or launched in full flight. The United States had five rigid airships in service with our Flying Fleets between 1920 and 1933. Four were wrecked, one was finally decommissioned and scrapped.



(*Official Photograph U.S. Navy*)

This is a K Class non-rigid airship

Flying Fleets

THEIR HISTORY

Flying Fleets

THEIR HISTORY

Aviation was already many years old before the U.S. Navy paid much attention to it. Skipping over legendary and prehistoric aspects, human flight began on November 21, 1783, when Pilâtre de Rozier and the Marquis D'Arlandes made their perilous voyage over the rooftops of Paris in one of the Montgolfier brothers' hot air balloons. But a hundred years more went by before anyone discovered how to make a balloon do anything but drift with the wind. Many sought a solution to the problem of dirigibility. Some tried oars, some tried sail. All failed. Later, others developed "air screws" designed to be driven by human power or by steam engines. A few came close to success. Meusnier, as early as 1785, sketched up an airship that might have flown had he lived long enough to build it. Giffard actually flew a small steam-driven airship from Paris to Trappes on September 24, 1852. His was undoubtedly the first airship flight, but his machine had only limited dirigibility. It was not capable of taking off and returning to its starting point at the will of its pilot.

Two French army officers, Renard and Krebs, finally pointed the way out of the dilemma. On August 9, 1884, they launched their electrically driven airship *La France*. It was a success from the start. For the first time in history men were able to take to the air and steer to a desired point and return without regard for the direction of the wind. There are vast differences in detail between *La France* and a modern airship, but fundamentally each is an aggregate of the same elements—an elongated gas bag for support, steering vanes for control, a suspended structure for housing pilots and passengers, power plants for propulsion. But

although the airship was the earliest form of practical aircraft, interest in it as a naval auxiliary is now at a low ebb. Today the airplane is far and away the most acceptable type of aircraft in the U.S. Navy. Both types have figured in the history of naval aeronautics. They have come along together, but to avoid confusion, the history of lighter-than-air has been treated separately from the story of heavier-than-air in this book.

LIGHTER-THAN-AIR

Before the war of 1917-18 the Navy took little official interest in lighter-than-air craft. A few casual studies had been made of free ballooning as a means of scouting and observation. Some naval officers had engaged in ballooning as a sport. Military and naval observers had followed closely the Zeppelin developments in Germany, and had kept an eye on airship work in England and France. The Army dabbled about with lighter-than-air prior to 1910, but the Navy owned no airships until we were well into the war. In the postwar years, however, we went through a period of intensive airship development. Lighter-than-air activity in the Navy finally reached a peak in 1928-30 with the commissioning of the *Akron* and *Macon,* two $3,000,000 rigid airships. The loss of these two ships put a serious crimp in official interest in lighter-than-air. Only recently has it shown signs of revival.

The Navy's first airship was not a success. A small experimental non-rigid (DN-1) appeared early in 1917, but tests were so disappointing it was soon abandoned. A modified design, the class "B" airship, did quite a bit better. It was of a type similar to the "blimps" developed in England during the early stages of World War I. Sixteen were built and delivered to the Navy late in 1917, and early in 1918. By war's end, most of them were on training duty. They led the way to the "C" class airship, a thoroughly workable military machine of which ten were delivered before the Armistice. Their performance was so good that one of them, the

C-5, was groomed for a trans-Atlantic attempt early in the spring of 1919. Unfortunately, on the eve of departure, a gale tore her from her moorings. She was blown out to sea and lost.

During the next twenty years a series of improved non-rigid airships was acquired by the Navy. Each model took a new alphabetical designation. We are now up to "K" and "L." The "J" class has only recently gone out of service.

With the outbreak of the war in Europe in the fall of 1939, the Bureau of Aeronautics again became interested in the possibilities of non-rigid airships for patrol duty from newly acquired bases in the Atlantic and Pacific. Some 48 "K" and "L" class blimps are now on order. The "K's" are the largest non-rigids ever built. They are designed for long range patrol and scouting work. They can stay in the air for several days at a time. The "L's" are smaller —similar to the Goodyear passenger-carrying blimps seen over many U.S. cities. They are considered primarily as trainers for the larger ships.

Rubberized cloth has been and still is the accepted material for gas containers for non-rigid airships. The Navy has made only one serious effort to get away from fabric as an envelope material. About 1926 a contract was let to the Metalclad Airship Corporation of Detroit for a non-rigid dirigible, the ZMC-2, with an envelope made of sheets of aluminum alloy only 0.008 inches thick. The ship was commissioned in 1929 and has just been dismantled at Lakehurst. After more than ten years of service the metal bag is in excellent condition. This performance encouraged the design of a similar airship of much larger size (3,000,000 cubic feet), but Congress has never seen fit to provide the money for its construction.

The Navy has never had much interest in the semi-rigid type. It purchased one from Italy in 1919, designated as the "O" class. It was set up and operated at the Naval Air Station at Cape May but proved unsatisfactory and was withdrawn from service after only a few months.

The rigid airship was early selected as the most useful type for fleet co-operation. Before the end of the war of 1914-18 a joint Army-Navy Airship Board recommended that the United States acquire two rigid airships for test, one to be built in this country and one in England, construction to be carried on concurrently. The British ship was built at the Royal Airship Works at Cardington and was launched as the R-38. On U.S. naval records she was carried as ZR-2. She was of fundamental Zeppelin design with minor modifications and the largest airship to be built up to that time. Her length was 695 feet and she was 85 feet in diameter. She could travel 70 miles an hour on six 750 horsepower Sunbeam engines. By August 1921 the R-38 had gone through most of her acceptance tests and was almost ready to be turned over to U.S. crews when she was destroyed in flight over the River Humber near Hull, England. The trouble began with a relatively minor structural failure when the ship was put into a sharp turn. Fire broke out, followed immediately by the explosion of the hydrogen. Only five of her crew of 50 officers and men escaped.

The Navy had somewhat better luck with the American-built airship. The ZR-1 was based on the design of the German Zeppelin L-49. Most of her parts were fabricated at the Naval Aircraft Factory at Philadelphia, and she was assembled and fitted out at the Naval Air Station at Lakehurst. Not quite as large as R-38, she was 680 feet long, 79 feet in diameter. Test flights were run off in September 1923 and a few weeks later ZR-1 went into commission as the *U.S.S. Shenandoah,* "Daughter of the Stars."

Shenandoah was the first rigid airship in the world to be inflated with helium. The Navy had had a tragic lesson from the explosion of R-38, and a year before the Army had lost the hydrogen-filled semi-rigid *Roma* by fire. Fortunately, large sources of the non-inflammable gas, helium, had been discovered in the Texas oil fields. A helium extraction plant was built at Amarillo and orders were issued in 1921 that thereafter no Navy airship should be inflated with anything but non-inflammable gas.

The Navy learned a lot from the operation of *Shenandoah*. She worked with the fleet as a scout. She made many notable overland flights. For almost two years she was an active part of U.S. naval aviation. On September 3, 1925, however, while flying westbound over Ohio she ran into a severe line squall which proved too much for her. She broke up in full flight—parts, including the control car, plunged to the ground killing 14 of her officers and crew. Other sections drifted off as free balloons to make safe landings some miles away. No one was to blame for her destruction. She had simply met up with natural forces beyond those contemplated by her designers.

When the *Shenandoah* went down, the U.S. Navy lost half of its active airship fleet. The other half was the German-built *Los Angeles* which had been acquired as a part of the reparations payments at the end of the war. She went through the Zeppelin factory at Friedrichshaven as the LZ-126. She was test flown in September 1924, and a month later, in the hands of a German crew, crossed from Friedrichshaven to Lakehurst. Altogether, *Los Angeles* had a long and useful career with the Navy which terminated only with her decommissioning in 1932. She cruised as far as Panama, shuttled back and forth across the United States, and was the trial horse for any number of aeronautical, navigational and radio experiments. She not only created a great impression for reliability and usefulness of the airship to the Navy, but was also the means of training officers and men to handle other airships. Her decommissioning was entirely in the interest of economy. She probably had many more years of active life in her when she was laid up at Lakehurst. Although she was kept in readiness for flight for a number of years, she never again took to the air. But her usefulness was not at an end. She was the subject of many tests and of continuous research on structural and other problems. She was moored out experimentally in all kinds of weather. She was used extensively to train ground crews in the

technique of handling airships. She was finally broken up for scrap in 1939.

Early experience with *Los Angeles* was so promising that the Navy embarked on an ambitious lighter-than-air program in 1928. Two rigid airships of unprecedented size were ordered from the Goodyear Zeppelin Corporation at Akron, Ohio. Where *Shenandoah* and *Los Angeles* were of some 2,500,000 cubic feet capacity, the new ships, *Akron* and *Macon,* far and away exceeded any airship that had ever been built with a capacity of 6,500,000 cubic feet. It was felt, however, that enough had been learned of airship structure and operation to undertake the building of aircraft of such large size without any intermediate steps.

But subsequent events proved that we had over-reached ourselves. *Akron* was the first to go into commission, October 27, 1931. She got through her trials successfully and served just short of a year and a half with the Navy. In the spring of 1933, while running out to sea off Barnegat Light, New Jersey, in an effort to avoid a storm, she ran into conditions which got the better of her and she was lost with almost all hands. Among the officers who died that night was Admiral William A. Moffett, Chief of the Bureau of Aeronautics, one of the men who believed most firmly in the possibilities of rigid airships as naval vessels.

The sister ship *Macon* went into commission on June 23, 1933. During the following year she made a number of long cruises and operated successfully with the fleet. While taking part in maneuvers with the Pacific fleet in the spring of 1935, she experienced what first appeared to be an insignificant structural failure near the stern, but which proved to be fatal. She came down at sea some miles off Point Sur, California, but all but two of her crew of 84 were rescued.

The loss of the two American-built rigid airships put a decided damper on the lighter-than-air program. Altogether, the United States had spent some $11,000,000 for the construction of four airships, none of which survived more than two years.

After the *Macon* went down in 1935, the President appointed a board of scientific and naval people, headed by Professor William F. Durand of Stanford University, to review the situation. After studying the airship problem in general, and the behavior of U.S. airships in particular, the Board found that there was nothing inherently unsafe in the rigid airship, and recommended continued development. Airship people were relieved by the findings of the Committee, but their enthusiasm for the airship has been held in check during the years that have followed because of lack of appropriations by the Congress. Although the Navy has announced that it is a part of its policy to encourage the construction of experimental airships for both civil and military use, no Congress since 1935 has seen fit to authorize the expenditure of sufficient money to build another rigid airship. At the present time designs and specifications for new craft of this type are collecting dust in the Navy's files. How long it will be before anyone digs them out and calls for bids on new ships, will depend on Congressional reaction to the course of events of the next few years. Possibly the fact that a recent Congress has appropriated money for the purchase of a batch of non-rigid airships may presage an eventual change of heart towards the rigid airship.

HEAVIER-THAN-AIR

The history of heavier-than-air craft is chronologically shorter than the story of the balloon and the airship. Again skipping legend and tradition, it got away to a slow start when Sir George Cayley began experimenting with small gliders about 1804. He found that a simple wing attached to a stick, fitted with a rudimentary tail, would glide considerable distance before coming to earth. It was almost fifty years after that, however, before anyone got around to building a glider big enough to carry a man. Le Bris, a retired Breton sea captain, built a gull-like machine in 1854 in which he claimed he soared in the air when towed

behind a horse and cart. But the evidence is somewhat sketchy and certainly his results were scarcely good enough to encourage any of his contemporaries to build gliders.

The first man to make a thoroughly scientific approach to the gliding and soaring problem as a prelude to powered flight was the German, Otto Lilienthal. Beginning in 1891, he made thousands of gliding flights on which he kept careful and painstaking records. Unfortunately, he was killed in a crash in 1896.

Lilienthal's work was the spark that touched off a great enthusiasm for gliding. Pilcher in England, Montgomery and Chanute in America, Archdeacon and Ferber in France, soon were hopping off hilltops, building up in the process a rich background of knowledge of wing sections, of materials, and of methods of balancing gliders in the air. Hargrave, Bell and others used kites to explore new ways and means of getting enough lift out of the thin air to carry a man aloft. Their contributions were not inconsiderable. By the turn of the century the stage was set for Langley, the Wrights and Santos-Dumont to take the final steps that brought the airplane into being.

Until then one thing had been missing—the one element for lack of which the development of both lighter-than-air and heavier-than-air craft was seriously hampered—a lightweight power plant. In the end, it was the same thing that made the automobile practical that made the airplane possible—the internal combustion engine. For years, men had labored in vain to make steam engines or electric motors light enough to power airships or airplanes. The best they had been able to build weighed 50 or 60 pounds for every horsepower developed. Engines used in high performance airplanes today deliver one horsepower for every 1½ pounds of their weight. Such a thing became possible only with the appearance of the multi-cylinder high speed gasoline engine. Charles Manly of the Smithsonian Institution came nearest to success earliest. The five-cylinder engine that Manly built in 1903 for Professor Langley, with its 52 horsepower and all up

weight of 125 pounds (2.4 pounds to the horsepower) was a remarkable achievement. It was some years before any airplane engine designer equaled that performance. Some engines do not show up as well even today.

There are few more tragic figures in aviation history than Samuel Pierpont Langley for whom Manly built his engine. Langley became interested in aeronautical problems as early as 1886 when he was a professor at Western University of Pennsylvania in Pittsburgh. A natural-born experimenter, he tested many wing shapes and bird forms on a "whirling arm" device—the predecessor of the modern wind tunnel. By 1890 he was convinced that mechanical flight was possible. In the meantime, he had left the University and had joined the Smithsonian Institution at Washington. There he began serious work with flying models. In this he was following in the footsteps of John Stringfellow who had flown the first powered airplane model in 1848.

In the following five or six years he built a series of model "aerodromes" which he tested by catapulting them from the roof of his houseboat in the Potomac River. On May 6, 1896, one of these machines made a flight of well over half a mile. As a result the War Department allotted Langley $50,000 for the construction of a man-carrying machine. It was at this stage that Manly went to work on his engine. It was not until late in 1903 that the aerodrome and engine were ready for trial. First flight was attempted on October 7th. It was a complete failure. The launching mechanism faltered, the aerodrome plunged into the Potomac River. Retrieved and rebuilt, it was tested again on December 8th. The machine collapsed before it was fairly launched. Langley's work ended in a blaze of Congressional recrimination and public ridicule.

Meanwhile, a couple of bicycle manufacturers from Dayton had been quietly working with kites and gliders in a lonely spot on the North Carolina coast. Only nine days after Langley's aerodrome slid off the starting rails and into the Potomac "like a

handful of mortar," Orville Wright opened a new era with a flight of 12 seconds at Kitty Hawk. Determination and ingenuity plus long and untiring research had brought to Wilbur and Orville Wright the solution of a problem that had baffled man for centuries. Like Langley, they had found no engine available that could possibly meet their requirements. Like Manly, they set to work to build one for themselves. Their final success was the direct result of the solution of the engine problem.

After they had proved what could be done at Kitty Hawk, they moved their activities back to Dayton. For five years they continued without pause to improve their machine and engine. By 1905 they were able to make flights of many minutes' duration. They could make circles and figure eights in the air. By 1908 they felt that they had achieved mastery of the air.

Looking back to the history of that period between December 1903 to September 1908, it is curious to note how little real attention was given the airplane by the people in this country. As a matter of fact, for several years after the first success at Kitty Hawk, the Wrights were able to continue their experimental work at Sims Station almost in a vacuum as far as public or official cognizance was concerned. No one seemed to comprehend that a successful airplane had actually come into existence.

The Wrights took a machine to Washington in the summer of 1908 to demonstrate to the U.S. Army. They suffered a temporary set-back when it was wrecked at Fort Myer in September, killing Lieutenant Thomas Selfridge. It was only when they came back to Fort Myer in August 1909 and proved beyond doubt that they had a practical flying machine that would meet military specifications, that the importance of their work finally dawned on the American public.

It was at the 1908 demonstration that the Navy became interested in the possibilities of the airplane. It sent a couple of officers over to Fort Myer to see what was going on. They had turned in enthusiastic reports. They had said, "The Navy must have that

—it will be most important to us." It was several years before the Department could accept the report at its face value.

Simultaneously, work had been going on quietly in a little town in up-state New York that was to have as much influence on the course of naval aeronautics as the pioneering work of the Wright brothers. At Hammondsport, a young fellow named Glenn Curtiss had opened a bicycle shop in the spring of 1900. He built and raced his own bicycles. Possibly because he was a bit lazy, or more likely because he wanted to go faster than his legs could pedal him, he began to toy with the idea of building a bike with a lightweight motor to drive it. In due course, Curtiss became a successful builder of motorcycles. He raced his own machines. He set a few world records.

About the time Curtiss started his motorcycle building, Thomas Scott Baldwin was building airships in California. Baldwin had a reasonably good airship but he was continually having trouble with engines. Attracted by Curtiss' success with his motor bikes, Baldwin came east to Hammondsport to ask his advice on building an airship engine. He had little trouble in arousing Curtiss' interest. For three or four years the two collaborated. Baldwin airships with Curtiss engines made records at every airship meet in the United States. Tom Baldwin was pilot, Glenn Curtiss, engineer. Early in 1909 the U.S. Army purchased its first military aircraft, the Baldwin airship SC-1, powered with a Curtiss motor.

Several years earlier a meeting had occurred in New York City that was to leave its mark on American civil and military aeronautics. Dr. Alexander Graham Bell, inventor of the telephone, had been following with interest the work of Lilienthal, Chanute and Hargrave. For several years he flew experimental kites at his summer home in Nova Scotia. Hearing of the success of the Curtiss motors and the Baldwin dirigible, he arranged a meeting with the engine builder to discuss possibilities for a lightweight engine in a large kite for experimental purposes. Shortly came the formation of the Aerial Experiment Association, whose primary pur-

pose was—"to build a practical airplane which will carry a man and be driven through the air by its own power." The original group included, Bell, Glenn Curtiss, F. W. Baldwin, J. A. D. McCurdy, and Lieutenant Thomas Selfridge. Mrs. Bell put up the money for experimental work. The Association established its headquarters at Hammondsport to be near the Curtiss factory. Each of the members designed and flew airplanes powered with Curtiss motors with varying degrees of success. Of the group, Curtiss himself went farthest. He called his original design the *June Bug*. With it he won a prize offered by the *Scientific American* by a flight of 2,000 yards on July 4, 1908. He was in the air just under two minutes. He built a second machine for the Aeronautical Society of New York City and flew it from the Morris Park race track. On July 17, 1909, he won the *Scientific American* trophy for the second time in a sustained flight of 25 miles at a speed of 35 miles an hour. That flight earned him the right to represent the United States at the Gordon Bennett Cup Races at Reims, France, later that same year. He won the trophy for the United States at a speed of 46.4 m.p.h. for two laps around a five-mile course.

The following summer he flew one of his machines from Albany to New York to win $10,000 posted by the *New York World*. It was on that flight that Curtiss resolved to put into execution an idea that had been in his head for a long time. Two years before he had mounted the old *June Bug* (renamed the *Loon*) on a pair of canoe-like floats, and had attempted to fly it off the water at Lake Keuka. The experiment had been unsuccessful. In those days, planing surfaces and "steps" for hulls were unknown. The floats added too much weight and the engine lacked sufficient power to break the suction between the surface of water and the smooth bottoms of his floats. After the Hudson flight, however, Curtiss was convinced that the usefulness of the airplane could be immeasurably extended if some sort of float gear could be developed. Commenting later, he said: "It was

while on that trip that I decided to build an airplane that would be available for starting or landing on the water. I don't know that I had the idea of its military value when I first planned it, but it came to me later that such a machine would be of great service should the Navy adopt the airplane as a part of its equipment."

But the Navy had to be sold. Even after the successful Wright trials of 1909, and after Glenn Curtiss' spectacular performances in France and in America, the Admirals were still skeptical.

At least one man in the Navy Department, however, had some idea of the airplane's potentialities. Captain W. I. Chambers had been watching developments with interest. In 1910 he went actively to bat for naval aviation. He had a hard job ahead of him. Few officers of the Navy could see how the flimsy machines of the time could serve any useful purpose with the fleets at sea. Chambers needed a spectacular demonstration of some sort to show what airplanes could do. Soon he and Glenn Curtiss had their heads together.

Not long before, the *New York World* had suggested to Curtiss that he should try launching an airplane from the deck of a ship at sea and have it fly back to shore carrying mail or messages. From a publicity point of view, the idea was a wow. The Hamburg-American liner *Pennsylvania* was fitted with a platform over her stern long enough for the launching of a standard Curtiss pusher. J. A. D. McCurdy of the Hammondsport group, was detailed to make the attempt. But, at the last minute, the show had to be called off. An accident to the propeller of the airplane just before the ship was due to sail washed out the experiment. Prodded by Captain Chambers, the Navy picked up the project at that point. The armored cruiser *Birmingham*, then at Hampton Roads, was offered for a test. A wooden runway, 60 feet long, was built over the forward turret, extending out over her bow. Eugene Ely, one of Curtiss' former pupils, put his Curtiss biplane

on board, and on November 14, 1910, made a successful take-off.

The Navy Department half-opened its official eyes. If it were possible to launch an airplane from a battleship—how about landing one on board? Curtiss, then on the point of moving his activities to the West Coast, thought it could be done. In December 1910 he received authorization to make an experiment on board the *U.S.S. Pennsylvania* then at San Francisco. A wooden platform, 125 feet long by 30 feet wide, was erected on her quarter-deck and a rudimentary arresting gear was installed. Ely went west and supervised the installation on the cruiser. On January 18, 1911, he carried out the test successfully, taking off from the Presidio in San Francisco and landing easily on the *Pennsylvania's* stern. To clinch matters, he turned his airplane around, took off, and returned to the Presidio without difficulty. Here was the genesis of the airplane carrier of today.

Encouraged by the *Birmingham* and *Pennsylvania* experiments, Curtiss moved to San Diego and began to develop actively the idea that he could build a machine to rise from and land on the water. Among a group of officers detailed to Curtiss for instruction was Lieutenant Theodore G. Ellyson, U.S.N., whose enthusiastic work contributed greatly to development of the hydro-airplane.

The crew at North Island went to work on the problem. Almost every day some new kind of float gear was tested, but the machine resisted all efforts to get her off the water. On the 26th of January (1911) a float was installed which embodied several brand new ideas. Curtiss took the machine out, intending to make a few preliminary taxiing tests, but unexpectedly, it came out of the water easily and took to the air. With as little difficulty, the pilot was able to put it down on the surface again. At last, a workable design had been found. The seaplane had come into being. Improvements followed rapidly. Finally, a demonstration was made that accelerated naval interest in the airplane.

Some months before, during preliminary negotiations with the

Navy Department, the Secretary of the Navy had written to Glenn Curtiss as follows: "When you show me that it is feasible for an aeroplane to alight on the water alongside a battleship and be hoisted aboard without any false deck to receive it, I shall believe the aeroplane of practical value to the Navy." Here was a challenge which he had been eager to meet. Now Curtiss was in a position to accept it.

On February 17th he took off from the North Island base, flew out to the *Pennsylvania* and landed alongside. A rope sling was fitted to the airplane and he was hoisted on board by one of the ship's cranes. After paying his respects to Captain Pond, the procedure was reversed. He was put over the side, took off the water and returned to North Island. This demonstration enabled Captain Chambers to secure from the Congress a $25,000 appropriation for aviation, and also earned for Glenn Curtiss the Collier Trophy for 1912 ". . . for the greatest achievement of aviation in America."

The real history of aviation in the Navy dates from 1911. For the first time funds were available for development, and Captain Chambers was detailed to the Bureau of Navigation and directed to undertake the establishment of an air arm for the Navy.

First move was to train some pilots. Ellyson had already learned to fly. Three other young officers, Lieutenant John H. Towers, Lieutenant John Rogers, and Ensign V. D. Herbster, were detailed for aviation duty. They were sent to flying schools that had been established by the Wright brothers and Glenn Curtiss. Concurrently, the first naval air station was set up at Greenbury Point near Annapolis. One Wright and two Curtiss airplanes were procured and sent to the station. In 1912, six other officers were assigned to aviation, bringing the strength of the unit to ten officers and three airplanes. Aviation in the Navy was definitely on its way.

The Curtiss hydro developed in San Diego in 1911 was what we now call a seaplane. In a seaplane, the float gear is generally inter-

changeable with wheels to convert the machine to land use. The flying boat came along a little later. In a flying boat the body of the airplane itself is also the hull on which it floats in the water. To some flying boats, wheeled landing gear has been added, generally carried along with the aircraft in flight in some retracted position. Such machines are amphibians because they may be put down either on land or on water.

It was after the development of the seaplane that Curtiss conceived the flying boat idea. The first machine of this type was tested in San Diego on January 10, 1912. It was not particularly successful. It was merely a modification of the standard Curtiss hydro in which the engine had been lowered from its original position between the wings into a sort of cockpit in the hull. It drove two tractor propellers through chains and sprockets mounted in somewhat the same fashion as in the early Wright biplanes. The pilot sat behind the engine in a second cockpit in the hull. The real prototype of today's flying boats, however, was Curtiss' number two machine, the *Flying Fish,* tested on Lake Keuka at Hammondsport in July 1912. It had a long narrow hull with seats for two pilots in a cockpit ahead of the lower wing. The engine was restored to its initial position between the wings and drove a single pusher propeller.

A year later, Lieutenant John H. Towers collaborated with Glenn Curtiss on the design of the first of the really large flying boats, the *America,* designed and built for Rodman Wanamaker for a projected trans-Atlantic flight. Although built for a private citizen, *America* attracted the Navy's attention because of her possibilities as a long range patrol plane. The outbreak of the war in 1914 headed off the attempt to fly the ocean, but the lessons learned from that design stood us in good stead when we finally went to war. *America* was one of the immediate ancestors of the famous F and H type flying boats that became standard equipment in the U.S. Navy during 1917 and 1918.

Although Ely had demonstrated in 1910 that it was quite possible to take off and land an airplane on a battleship, the method employed was obviously unsatisfactory. Landing platforms on battleships seriously reduce the effectiveness of the ship as a fighting unit, so other means of launching had to be considered.

First experiment in this direction was made at Hammondsport in 1911 by Lieutenant Ellyson. The plan was to take off from a steel cable stretched between suitable supports. Ellyson actually made several "tight rope" take-offs, but the installation of such a long cable on shipboard seemed impractical. Chambers revived the idea of the catapult. If airplanes could be "shot" into the air from ships' decks, they might, on returning, land in the water alongside and be hoisted aboard with a crane.

Catapulting aircraft was not, strictly speaking, a brand new idea. Chanute had launched gliders from catapults in 1896, and Langley had set up an elaborate arrangement on top of his houseboat to launch his aerodromes. As late as 1909, the Wright brothers were using a system of pulleys and a falling weight to assist in launching their airplanes. The last Wright catapult involved a track some 50 feet long and a falling weight of three-quarters of a ton.

But falling weights and greased slides seemed as impractical on shipboard as the tight rope. Naval constructors began thinking about compressed air and gunpowder as possible propellants.

The Naval Gun Factory at Washington was assigned the job of building the first compressed air catapult. No funds were available, but by scouting about through Navy Yard junk piles an old torpedo tube, a scrapped air tank, and some hoisting gear salvaged from the old *U.S.S. Oregon* provided the necessary material. The catapult was first tested with sand bags and developed all the acceleration needed along its 30-foot track to bring an airplane up to flying speed. Main questions centered about the releasing gear, and the ability of the pilot to take the launching shock. After mechanical testing it was shipped to the Santee

Dock at the Naval Academy at Annapolis, and Lieutenant Ellyson undertook to make the first take-off. In spite of careful preparations, something went wrong. The plane plunged into the Severn out of control. Fortunately, Ellyson was not hurt. Three months later, November 12, 1912, he made the first successful catapulting flight in an airplane at the Washington Navy Yard. In the meantime, Captain H. C. Richardson had completely redesigned the equipment and had eliminated the causes of the Annapolis crash.

The prototype of the modern catapult equipment was the installation on board the *U.S.S. Maryland* completed in 1921. Located on the quarterdeck, the catapult itself was mounted on a turntable so that the planes could be launched in any direction that would suit weather conditions. Today, every battleship and cruiser in the Navy carries one or more catapults and a complement of scout-observation planes. At first sight, catapulting may appear to be a hazardous operation, but out of the thousands of launchings that have been made from ship catapults, not a single accident fatal to personnel has occurred.

In 1911 and 1912, with the airplane less than ten years old, naval aviators set notable records. Lieutenants Ellyson and Towers flew a Curtiss seaplane from Annapolis to Old Point Comfort, Virginia, a trip of 146 miles. Shortly afterwards, Towers kept a Curtiss seaplane in the air for 6 hours and 10 minutes, and Lieutenant Pat Bellinger took a similar machine up to 6,200 feet.

The first real co-operative mission with the fleet was carried out in January 1913 when the entire aviation unit, under the command of Lieutenant Towers, was moved to Guantanamo, Cuba, for the annual winter maneuvers. There they demonstrated that airplanes could locate mine fields and submarines, and could scout out the location of enemy surface vessels. Many officers attached to the fleet who had been skeptical of the airplane's usefulness began to change their minds.

By 1913 aviation in the Navy was definitely on the upswing. In October the Secretary appointed a Board to make a survey of aeronautical needs and to establish a policy for development. Captain W. I. Chambers was appointed Chairman. One of the first recommendations was for the establishment of an aviation training station in the South. A site was selected in an abandoned Navy Yard at Pensacola, Florida, and early in 1914 all planes and pilots were ordered to Pensacola.

They set up shop in a row of tent hangars along a strip of sand beach. Wooden ramps ran from each tent to the water's edge for launching and beaching the boats. A heterogeneous collection of Curtiss hydros and flying boats and a couple of Wright pusher seaplanes made up the flying equipment.

Today, Pensacola can hold its own with any naval training center in the world. Broad concrete ramps, equipped with every possible device for handling seaplanes and flying boats of all sizes, lead up to concrete and steel hangars. Behind the hangars is one of the finest flying fields in the country, for Navy pilots must learn to fly from land or from carrier decks, as well as from water. Pensacola's shops contain equipment for overhaul and servicing of every type plane and engine on the Navy's lists. Beautifully planned barracks, mess halls, and recreation facilities are provided for the officer, cadet and enlisted personnel. Pensacola has come a long way from circus tent days of 1914.

Naval aviators got a foretaste of actual warfare in the brush between the United States and Mexico in 1914. During the attack on Vera Cruz in April, two airplanes were based on board the *U.S.S. Mississippi* and one on the *Birmingham*. The planes made daily flights far inland to observe military activities in and around the besieged city. The pilots' reports were extremely useful to the officers who were directing operations.

But the Mexican experience proved to be only a flash in the pan compared with the explosion of the spring of 1917. Few naval

officers had any real conception of the job that lay ahead when war was declared in April. We then had only one air station (Pensacola), a total of 38 naval aviators, and 163 men. The flying equipment consisted of unarmed hydros and embryonic flying boats, possibly a dozen all told. Wanamaker's *America* was the only "big" boat with which anyone in the United States had had any experience.

With the outbreak of the war the procurement problem became acute. What few manufacturers there were had neither experience nor equipment for anything like quantity production of aircraft. To help this situation, the Navy decided to build its own aircraft factory, not only to relieve the pressure on production, but also to serve as an experimental station. The Philadelphia Navy Yard was chosen as the site. Ground was broken on August 6, 1917, and 110 days later a factory 400 feet square with complete equipment was ready to go. Although such a building seemed huge at the time, before the war ended its floor space had been multiplied at least five times. In that period the Naval Aircraft Factory turned out 183 twin-engined flying boats, many of which saw service in France.

By the 11th of November 1918 naval aviation establishments in the United States had grown from 1 to 21. The total personnel had jumped to some 2,800 officers and 30,000 enlisted men. At war's end, another 3,880 student officers were in training. Out of the total number over 1,200 officers and 16,000 enlisted men went overseas. Twenty-two U.S. naval aviation bases were established in Europe during the war—12 in France, 7 in England, and 3 in Italy. Operating from these bases, our seaplanes and dirigibles assisted in convoying merchant vessels and transports, located and destroyed mines, and kept a look-out for submarines. Several heavy bombing squadrons piloted by Navy and Marine Corps personnel were attached to French and British commands. They participated in a number of raids against the German submarine bases in Belgium and the occupied Channel ports.

The U.S. Marine Corps had been interested in aviation since 1912 when Lieutenant A. A. Cunningham was assigned to flight duty. When the war broke out, however, the Marine Corps aviation unit consisted only of Lieutenant Cunningham and four other officers and 30 enlisted men. By the Armistice, this number had grown to some 270 officers and over 2,100 enlisted men. Four squadrons of Marine Corps aircraft arrived in France in August 1918. They participated in 57 raids over the lines.

The war ended just as U.S. naval aviation had acquired tremendous momentum. Planes and pilots were pouring into France and elaborate plans were under way for flying operations on an unprecedented scale for 1919. Among such was the program for constructing flying boats of very large size for scouting and patrol work in the North Sea and in the English Channel.

Early in 1917 a contract was let to the Curtiss Company for four 4-engine flying boats. They were larger than anything that had yet been built, with a wing of 126-foot span and a gross weight of over 28,000 pounds. Their four Liberty motors totaled 1,600 horsepower and their tanks had a capacity of 1,800 gallons. They were intended to be flown by a crew of five. The first of them, the NC-1, was test flown in October 1918.

At that time space on board transports going to France was at a premium—besides, large airplanes are difficult to handle on board ship. In order to get them overseas, it was planned to fly them under their own power—quite an ambitious undertaking, as no one up to that time had ever flown across the Atlantic in anything. The war ended before this plan could be carried out, but all those connected with it were anxious to go ahead and gain for the United States the distinction of making the first Atlantic crossing. The Department issued authority to make an attempt in the spring of 1919. Three of the NC boats were available, one of the original four having been damaged in test flights. On May 8, 1919, the expedition pushed off from the naval base at Rockaway,

New York. A stop was made at Trepassey Bay, Newfoundland, for fuel and to await favorable Atlantic weather. Finally, on the morning of May 16th all three got away after some difficulty at take-offs due to the extremely heavy fuel loads.

The following day, NC-4, in command of Lieutenant Commander A. C. Read, landed at Horta in the Azores. The two other boats failed to make it. The NC-1 had a forced landing some 200 miles east of the Azores, and her crew was picked up by a passing steamer. The NC-3 was forced down by thick weather, but continued her trip on the surface, taxiing some 205 miles into Ponta Delgado. The NC-4 continued alone, crossing to Lisbon on May 27th and continuing to Plymouth, England, on May 31st, completing the first Atlantic air crossing.

At the end of World War I we had our first opportunity to sit back and take stock of the worth of the airplane as a weapon of war and to see just where it really fitted into the Navy's picture. A number of new problems had been posed during operations abroad. In spite of the fact that appropriations were cut to the bone, and personnel demobilized to leave only a skeleton of an organization, development work was started to remedy some of the more obvious deficiencies.

One of the greatest obstacles to the use of the airplane at sea was the difficulty of launching and retrieving from battleships. The catapult offered a limited but not satisfactory solution for large-scale flying operations. Official thought went back to Ely's experiments on the *Birmingham* and *Pennsylvania* in 1910 and 1911. But the same objections came up that were then raised, mainly, the undesirability of cluttering up battleship decks with awkward platforms for landing and take-off. About 1921 the notion occurred to someone that it might be feasible to fit up certain ships as aircraft carriers, to make them virtually floating airdromes that could be used anywhere at sea. The collier *Jupiter* was set aside for the first experiment. She was decked-over from

stem to stern with a special superstructure and recommissioned as the *U.S.S. Langley.* The first launching and take-off were made on October 26, 1922.

She proved to be an efficient trial horse. Many kinds of arresting devices were tested out on her flight deck. Naval pilots soon became adept in landing and taking off on board. Very quickly it became clear that carrier operation was entirely sound, and plans were made to convert two heavy cruisers scheduled for scrapping under the Washington Treaty for the limitation of armaments—the *U.S.S. Saratoga* and the *U.S.S. Lexington.* Their original superstructure was replaced by a flight deck almost 900 feet long and just over 100 feet wide. Bridge, masts and funnels were trimmed down to minimum dimensions, and shifted to the extreme starboard side to keep the deck clear. Elevators were installed to bring up airplanes from the hangars below deck. Each ship was fitted with complete machine shops and repair facilities fully capable of servicing and maintaining the squadrons of aircraft assigned to it. These two ships became, in effect, completely equipped and highly mobile bases from which aircraft could be operated. They went into commission the latter part of 1927 and made their first appearance with the fleet in the spring of 1928.

During the ten years following, the aircraft carrier became an essential feature of our naval aviation. Based on the experience gained from the operation of *Saratoga* and *Lexington* a new series of ships was laid down in the early 1930's designed from scratch as aircraft carriers. As funds have become available, these fast-moving oceangoing airports have been added to our fleet. We now have seven in commission (*Lexington, Saratoga, Ranger, Enterprise, Yorktown, Wasp* and *Hornet*), four others building, and seven more authorized. Each of these ships carries approximately 75 airplanes—fighters, dive bombers, and torpedo carriers. When the program is completed in 1945 our two-ocean Navy will have 18 carriers with a total of over 1,200 fighting airplanes on board

—a formidable array that should give pause to any contemplated move in our direction from any part of the world.

During the reorganization period following the close of the war, it became apparent that all aviation activities of the Navy should be put under the jurisdiction of a special bureau. An Act of Congress dated July 12, 1921, created the Bureau of Aeronautics. On September 1, 1921, President Harding authorized the formation of the Bureau and appointed Rear Admiral William A. Moffett to be its first chief. The new Bureau became of equal rank and importance with the older units of the Navy Department—Ordnance, Yards and Docks, Navigation, etc. Aviation had finally been recognized as an independent and important function. It ceased being a departmental stepchild.

The Bureau of Aeronautics is charged with the design, construction, fitting-out, and maintenance of all naval and marine corps aircraft. Officers expert in many fields of aeronautical engineering and other specialties pertaining to the design of airplanes and engines are detailed to the Bureau. Its experts in aerodynamics work closely with the research people of the National Advisory Committee for Aeronautics, and with the manufacturers of aircraft. Its power plant section keeps fully conversant with the latest developments in engines of all types, in fuels and lubricants, and in propellers. The structural group is made up of officers and civilians who are more than familiar with the latest methods of putting airplanes together for the utmost strength and efficiency.

There is scarcely any sort of structural material that does not find a place in the Navy's airplanes. The alloys of aluminum and magnesium, of steel and of copper are widely used. More recently considerable interest has been evidenced in newer forms of materials, in plywoods and plastics, in molded reinforced plastics, in glass fabrics, in beryllium alloys, and in a host of other combinations that show promise of making aircraft lighter or stronger or faster.

By 1925 it had become clear that some definite formulation of policy for military and naval aviation was necessary. In September of that year President Coolidge appointed a committee to examine the problem and to determine the best application of aircraft of all types for national defense purposes. Dwight Morrow, later Ambassador to Mexico, was Chairman.

The Morrow Board made two recommendations that had an important bearing on naval aviation. First, a five-year development program was planned under which the Navy was to acquire an active strength of 1,000 airplanes and three airships. Second, in order to co-ordinate and to supervise these new activities, the post of Assistant Secretary of the Navy for Aeronautics was created. Edward Warner, then professor of aeronautics at the Massachusetts Institute of Technology, was the first to hold that office. He served from 1926 to mid-1929. During his term of office the Navy moved a long way toward the fulfillment of the first five-year plan.

Among the important technical developments of the period was the standardization by the Navy on the radial air-cooled engine. Air-cooled engines had been employed during the first World War, but they had been almost exclusively of the rotary type and had proven generally unsatisfactory for a number of reasons. Liquid-cooled engines (similar to the automobile power plants of the period) were not considered satisfactory for naval use due to the high incidence of mechanical trouble in the cooling system, with resultant forced landings at sea. It was largely due to the insistence by the Bureau of Aeronautics on the development of air-cooled types in the late 1920's that the radial air-cooled engine today powers all of the commercial aircraft in the United States and a large proportion of the tactical types both in the Air Corps and in the Navy. Recent improvements in liquid-cooled engines both in this country and abroad have brought the type back into prominence, but the bulk of the engines to be procured under

the emergency defense programs of 1940 and 1941 will be air-cooled.

Another notable contribution by the Bureau of Aeronautics during the same period was the substitution of metal for wood and fabric in the principal structural elements of all aircraft. The Navy had a particularly difficult problem in this respect because most of its operations are on or near salt water, and salt water is extremely corrosive for most metals and particularly for the lighter alloys of aluminum and magnesium commonly used for airplane construction. The Navy has had to wage a constant battle against dangerous deterioration of metallic parts of its aircraft. As a result, protective coatings and preventative methods have been evolved that have saved thousands of dollars for both military services and the commercial transport operators.

Navy technicians have also developed many new ideas in maintenance, in communication, and in navigation techniques that have been of tremendous importance. Some of the credit for the improvements that have been made in commercial aviation during the past ten years should go to the Navy and the Army. Both Services have also benefited from developments in commercial aviation. The co-operation has been complete. The semi-annual meetings of the Engineering and Maintenance Committee of the Air Transport Association of America are always attended by representatives of the Army and the Navy as well as the airlines. Information collected on any of a hundred different subjects of importance to the servicing and operation of aircraft is pooled in the common interest.

By the middle 1920's, problems of naval aviation had shaken down sufficiently to permit a certain degree of standardization of equipment. Six principal types of naval airplanes emerged for specific uses—for fighting, for patrol, for scouting or observation, for torpedo carrying or bombing, for general utility, and for training. Somewhat the same classification of aircraft has persisted to date.

During the naval maneuvers of 1928, it was demonstrated for the first time that aircraft in large numbers could operate successfully with the fleet. That was the first year that our carriers, *Saratoga* and *Lexington*, participated. A night raid with over 250 planes launched against the Panama Canal from carriers 150 miles at sea pointed up the need for improving the defenses of that vital zone.

The following year two other significant demonstrations were made, one in the Tropics and one in the Arctic. Political upheavals in Central America had forced the landing of U.S. Marines in Nicaragua. During operations far inland, Navy transports kept troops constantly supplied with food, ammunition, and necessary equipment. The country was extremely rough and without landing facilities except at prepared bases. The weather made flying difficult. But the aircraft performed all missions satisfactorily.

In the North, four Loening amphibians carried a survey party over thousands of square miles of Alaska. Aerial photographs of hitherto unexplored territory disclosed new sources of water power and new locations for military bases. The flight personnel gained a considerable amount of experience in sub-arctic operation.

An argument is sometimes advanced that airplane racing, like horse racing, tends to "improve the breed." Experience has indicated, however, that we get farther faster by depending on well-planned, day-in-and-day-out scientific research than by looking for spectacular advances out of racing machines. The Navy came early to this conclusion. Its participation in air racing has been on a modest scale. In 1923 a Navy racer was built by the Curtiss Company for the Schneider Speed Race (an international contest established in 1913, finally abandoned in 1931). That year Lieutenant David Rittenhouse showed his heels to the pack with an average speed of just over 177 miles an hour. There was no contest in 1924, but in the 1925 Schneider Race, America won

again. The machine was a Curtiss R-3 seaplane racer. It was flown by James H. Doolittle at an average speed of 232.57 miles per hour. After two straight wins, the U.S. Government officially gave up Schneider racing. It cost too much. The return was too small.

Naval aviation has played a great part in relief and rescue work in times of disaster. Naval aviators and naval planes have flown hundreds of tons of supplies and relief equipment into areas devastated by fire, flood, or hurricane. On many occasions, ships foundering at sea have been located and assistance attracted to survivors by naval aviators. In July 1937, when Amelia Earhart and her co-pilot Fred Noonan were lost in the Pacific on the last leg of their round-the-world flight, the *U.S.S. Lexington* was dispatched to search the area. At that time she was anchored off San Pedro, California. She made a record 4,000-mile run to Howland Island. The *Lexington's* complement, assisted by long range patrol planes from Hawaii, combed thousands of square miles of the Pacific before the search was abandoned.

Every year naval pilots distinguish themselves on missions of this sort. Frequently they work in co-operation with the Coast Guard both in the air and at sea. Coast Guard aviation, although in peace times operated under the Treasury Department, is closely allied to naval aviation. All Coast Guard pilots are Navy-trained. Much of the flying equipment is similar to that of the Navy—especially in the patrol and utility classes. In time of war all Coast Guard personnel, equipment, and activities are transferred to the jurisdiction of the Navy Department.

By 1935 it had become a well-recognized fact that the development of extremely long range flying boats was a necessary part of our defense program. This can be easily understood by referring back to the map on pages 6-7. By the end of 1937 our patrol squadrons had been re-equipped with flying boats of a size and range so that they could be safely ordered to proceed under their

own power to such remote bases as Pearl Harbor, Hawaii, and the Canal Zone. On December 8, 1937, 14 PBY's left San Diego and arrived at the Fleet Air Base at Coco Solo, Canal Zone, the following day, non-stop. On the 18th of January 1938 an 18 plane formation took off from San Diego and landed the following day at Pearl Harbor. These unprecedented mass flights were hailed everywhere as an outstanding accomplishment for U.S. naval aircraft. Today they have become routine. During the past few years dozens of individual machines have been ferried in formation over such distances. It has become so commonplace that such routine transfer flights get about the same notice in the newspapers as the departure of the *Queen Mary* on a regular sailing.

The Navy's first five-year building program which resulted from the recommendations of the Morrow Board was approved by Congress in June of 1926. It got under way slowly, but by 1929 definite progress was visible. By that time the Navy had on hand or under construction sufficient aircraft to support the fleet on any problem that seemed imminent at that time. On completion of the program in mid-1931 the Navy had on hand 1,000 useful airplanes.

That year also saw the first results of a policy set up some years before—the building of a large number of experimental machines for service test. Over 40 new types were delivered to the U.S. Naval Air Station at Anacostia and "given the works" by Navy pilots. By continuation of this policy, the Navy has been able to keep new types coming along that are constant improvements over machines in service or in production. Anacostia is generally a year ahead of the rest of the Navy in this respect.

The economic depression that began in 1929 touched bottom in 1932, and inevitably had a retarding effect on development of the Navy's flying fleets. The appropriations for new aircraft and for the maintenance of existing aircraft were cut to the bone, but

it stands to the Navy's credit that during that trying period a high degree of efficiency was maintained in the active units with the fleet, and a certain amount of experimental work was carried on. It was that year that two-place fighters with retractable landing gear began to appear on the flight decks of the aircraft carriers, and it was that year also that the two-row radial air-cooled engines now widely used for combat types proved worthy of acceptance.

The economy measures of the period kept the naval aviation strength at the 1,000 plane limit established in 1926 until the passage of the Vinson-Trammell Navy Bill in 1934. By that time the financial situation was generally easier and appropriations for Army and Navy aircraft began to climb slowly from the depression lows. The Vinson-Trammell Bill authorized the expansion of the surface Navy to limits agreed upon by the Washington and London Conferences for the limitation of armaments. Taking into account new aircraft required for two new carriers, six new cruisers, and the then existing Navy, the goal of the second aircraft-building program was set at approximately 1,900 airplanes. The machines were scheduled for delivery upon completion of the ships on which they were to be based, and a certain number of replacements of existing types was provided every year. Funds were set aside for research and development so that during this period of reconstruction the Navy could be assured of receiving planes and engines that were up to the highest specifications that engineers knew how to write. New air bases were provided, and a program of expansion of training facilities was inaugurated to meet pilot requirements.

In thinking about mass aircraft production today, we sometimes forget the accomplishments of 20 years ago. The Naval Aircraft Factory alone had a payroll of over 12,000 people at the end of the war in 1918 and was delivering two of the twin-engined flying boats per day.

After the Armistice of 1918, the Naval Aircraft Factory ceased to be a productive unit and for the next 15 years specialized on experiment and development. Its work supplemented the theoretical work of the Bureau of Aeronautics including testing and application of new structural materials for aircraft. One of the primary functions of the Factory is to shake down and put into final usable form the specifications for various parts and materials that are written in the Bureau.

Another part of its job is to check actual manufacturers' articles to see that they meet these specifications. For that reason extensive laboratories for engine, structural, and materials testing have been made an integral part of the Factory. Many improvements in aircraft and equipment have come directly from the work of the Philadelphia laboratories.

The Factory performs one other very important function, the carrying and distributing of supplies and basic raw materials for the repair and maintenance of aircraft throughout the entire naval aeronautical organization. Supplies are originally purchased and stocked in Philadelphia and then distributed as needed to the various units of the fleet and to the Naval Air Stations and other aeronautical establishments ashore.

With the passage of the revised Vinson-Trammell Bill in 1938, the Naval Aircraft Factory again went into production. The intention was to make it a "pilot plant" in which airplanes and engines would be built as a check on commercial manufacturers' quality and prices. As a practical matter, such a plan is scarcely feasible, as it is obviously uneconomical to try to build small production lots of all types of aircraft used by the Navy. The Factory has, however, been assigned the job of turning out primary trainers, and almost all of the elimination training and primary flight work at Pensacola is done on two-place, open cockpit machines built by the Naval Aircraft Factory. A considerable quantity of the Curtiss scout observation biplanes was built at the Factory. The basic design was SOC-1. They came out as SON-1

(the "N" of course standing for Naval Aircraft Factory, to replace the "C" for Curtiss).

But the Navy clearly can build only a fractional part of its aircraft requirements. It must depend primarily on the private manufacturers of planes, engines, and accessories for efficient aircraft of all types for its Flying Fleets. For years the manufacturing people have accepted specifications for Navy airplanes that were always a little better than they thought they knew how to make, and the Navy has seldom been disappointed in the results.

Contrary to popular notion, no airplane manufacturer has ever been able to make any tremendous profits on Army or Navy business. Many orders have been completed not only at no profit, but at substantial loss. Until the end of 1939, orders for military airplanes were small, specifications exacting, inspection close. With orders ranging from a dozen to a hundred machines at most, it is almost impossible to write off the large investment in engineering, in research and in tooling. For 20 years the manufacturers have existed on a hand-to-mouth basis that was either feast or famine as far as Navy purchase orders were concerned. It is only recently, with the placing of orders by our own Government and by foreign Governments on a scale never before realized, that anything like mass-production methods have been possible. Profits are still carefully restricted by law, but for the first time in the history of the aircraft-manufacturing industry, contractors for the Army and the Navy have a chance to realize a reasonable return on an investment of time and money and energy that for many years seemed destined to go down the drain.

It would be impossible to treat adequately here the contributions that have been made to naval aviation by such people as Boeing, Consolidated, Curtiss, Grumman, or Martin. In the picture section that follows, unmistakable clues testify to the continuing contributions that these and other manufacturers have made since the last war. The present high standards of perform-

ance and reliability now accepted as commonplace by the Navy's personnel would have been wholly impossible without the complete co-operation on the part of contractors. Through all the lean and uncertain years of development and depression, they have never let the Navy down.

The "normal" expansion programs for U.S. naval aviation came to a temporary end in the spring of 1940. We were then maintaining an active force of about 1,900 airplanes—the limit set for our second expansion program. By that time, the new war in Europe was almost a year old and general world conditions unstable to say the least. Suddenly the President of the United States began to talk in terms of 50,000 military aircraft for the United States. The Navy then began to think of aircraft on a scale far beyond the wildest estimates of its most enthusiastic aviation officers. Estimates jumped from two, to five, to ten, to fifteen thousand planes. They are now on the way to much higher figures. Engine requirements became sub-astronomical. Literally billions of dollars were allocated for defense measures and naval aviation suddenly found itself enjoying an embarrassment of riches. As this is written, we are slowly beginning to work our way out of this dilemma. The naval organization has been expanded by high-pressure training for new ground and flight personnel, and by the calling up of the reserves. Every factory in the land is being pushed to its maximum capacity and at the same time expanded as fast as brick and steel can be erected and workers assembled and trained—to meet the deadline for a 15,000 plane force for the Navy by mid-summer of 1942.

☆ ☆ ☆ ☆

So begins still another era for naval aviation—an era of unprecedented and possibly unlimited expansion. At the moment, no one can foresee when or how it may end. Fortunately, we are beginning to see where we are going. We entered the war in 1917 with only the faintest conception of what aviation was all about.

Today, the situation is quite different. The period of invention, of trial and error, is long since over. The airplane has established itself as an efficient means of transport and as an effective weapon of war. For 20 years we have had ample opportunity to study and to develop and to perfect our military flying equipment. Governmental and private laboratories have been unremitting in their search for better wings, better engines, better fuels. Designers have labored with charts, tables, and formulae to get the last possible ounce of performance out of their machines. Manufacturers have installed efficient productive machinery and have plans ready for wholesale productive methods to meet any requirement. At the moment we have everything we need except large numbers of aircraft. But that fault is now being remedied. The go-ahead signal has been given and the U.S. aviation industry can produce enough airplanes to literally darken the skies if necessary.

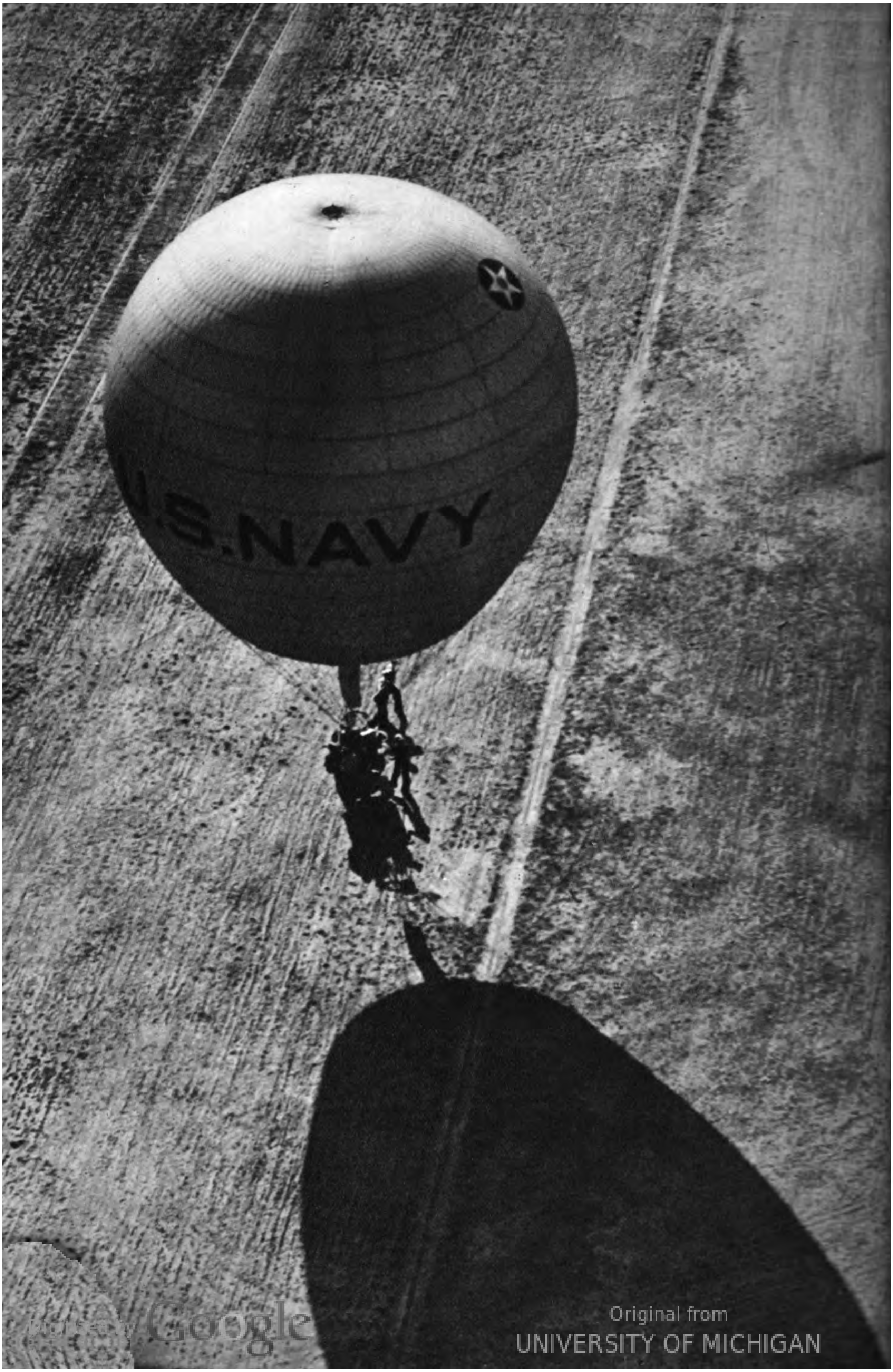
Meanwhile naval people have not been idle. New pilots are being trained by the thousands. New tactics are being developed to meet new problems as they arise. Naval aviation today stands ready to do its part in any emergency that confronts the Nation. Our fleets that fly stand shoulder to shoulder with the fleets afloat in the defense of America.

Flying Fleets

IN PICTURES

The illustrations in the following pages follow approximately the text of the preceding section. They have been arranged in groups, each group showing something of the history or activities of a particular branch of naval aviation. Within each group the pictures are in approximate chronological order.

Except where otherwise indicated all pictures are official photographs—U.S. Navy

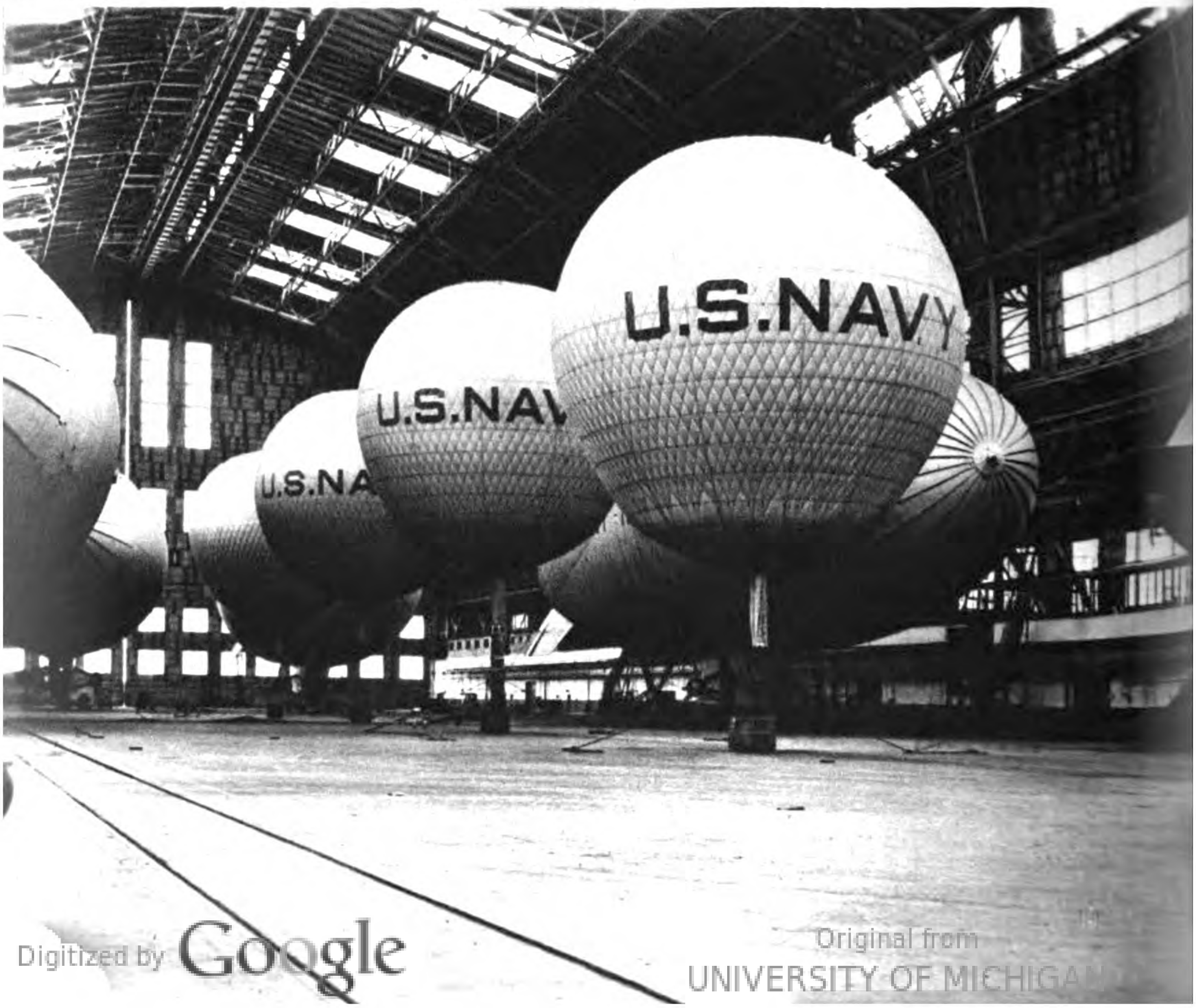

S.NAVY

LIGHTER THAN AIR

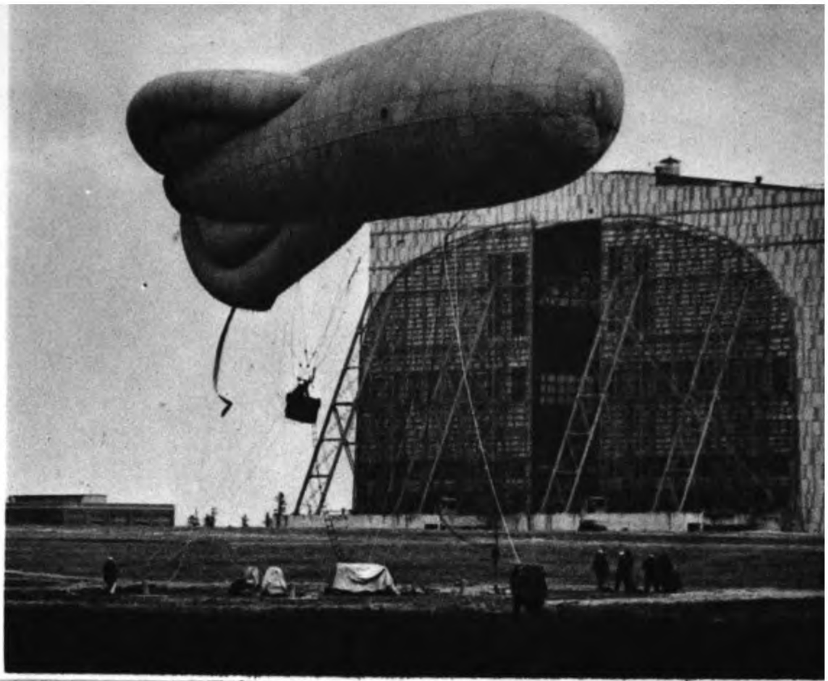
Balloons and Airships

A 35,000 cubic foot free balloon used for training or racing.

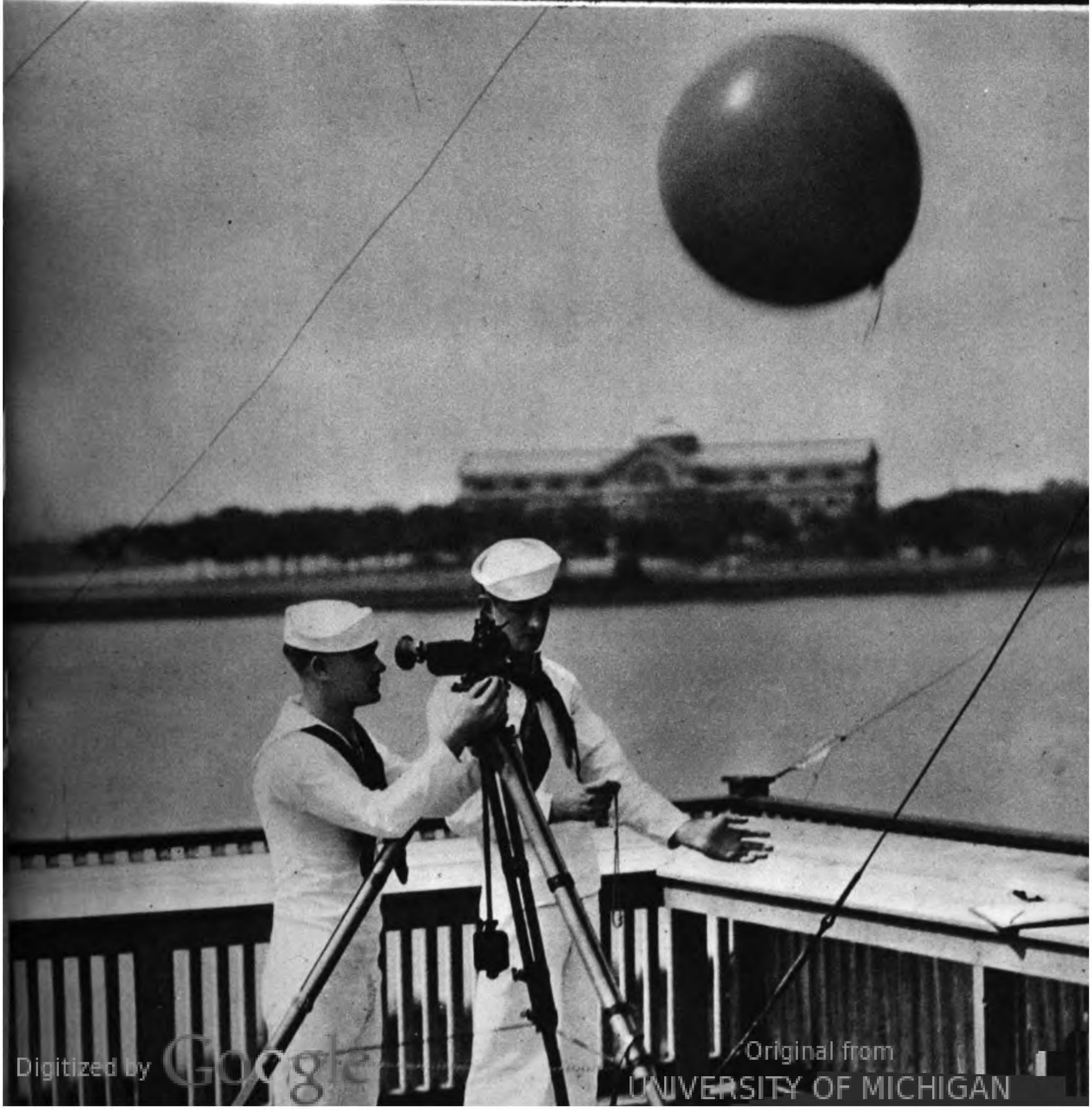
Navy lighter-than-air activities center at the Air Station at Lakehurst, New Jersey.

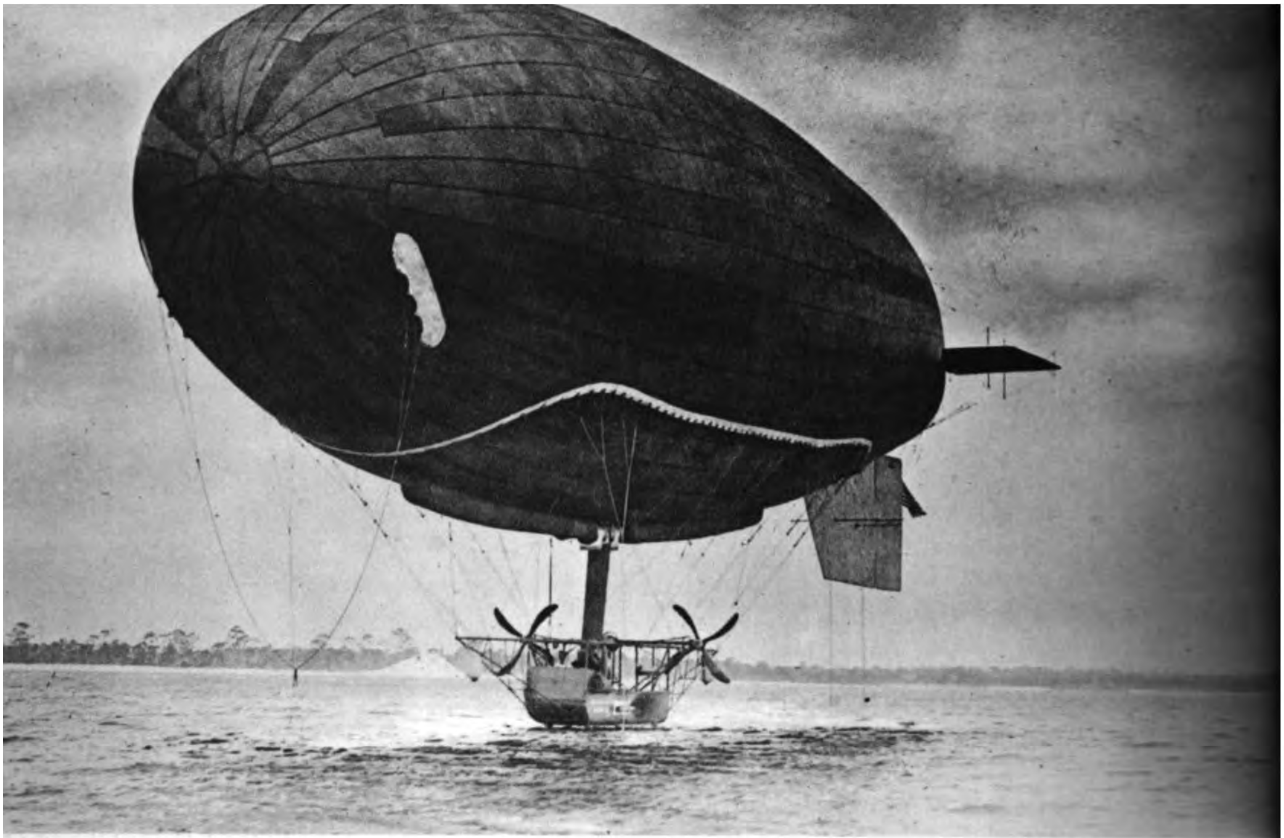


he Navy has a few kite balloons for observation purposes. This is a Type R.



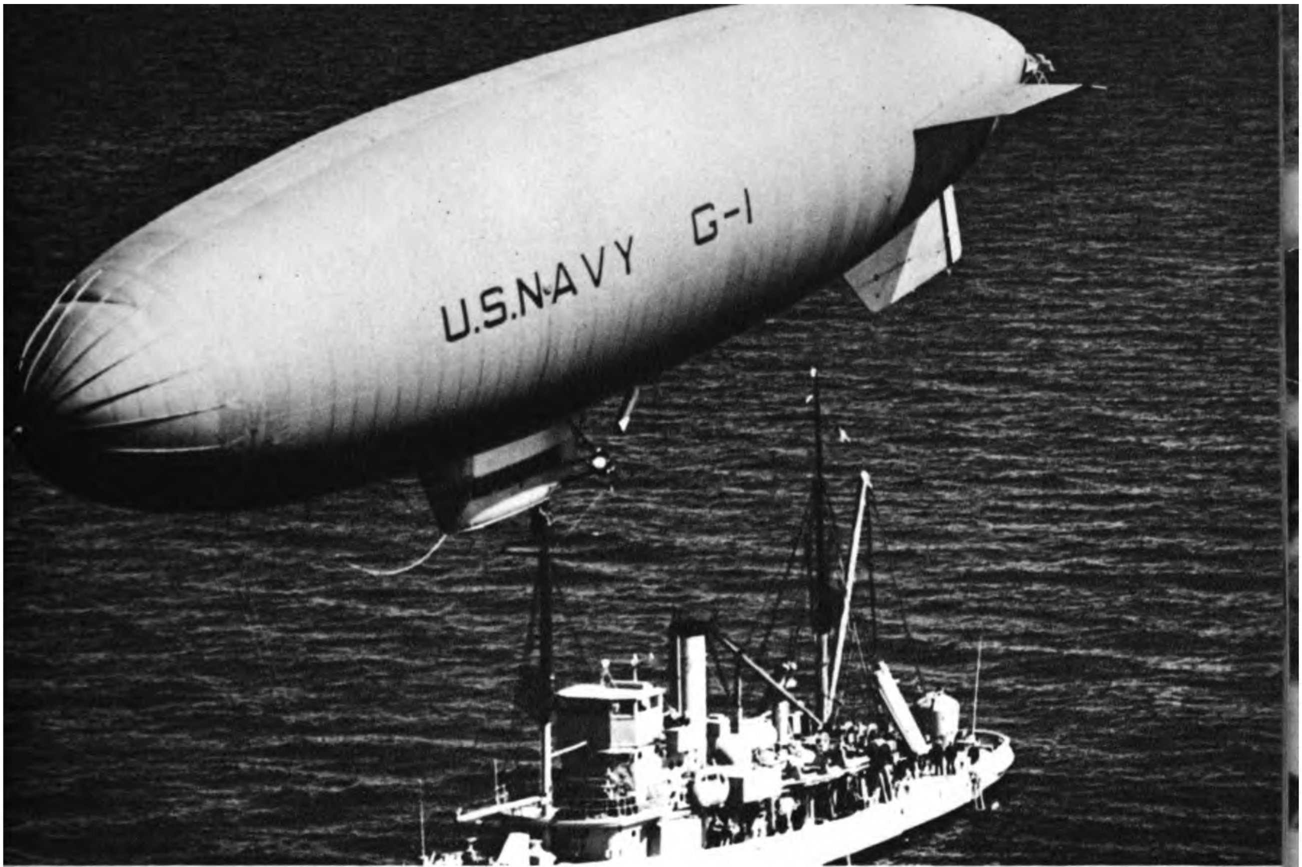
mall free balloons are sent aloft requently to check speed and irection of the wind.





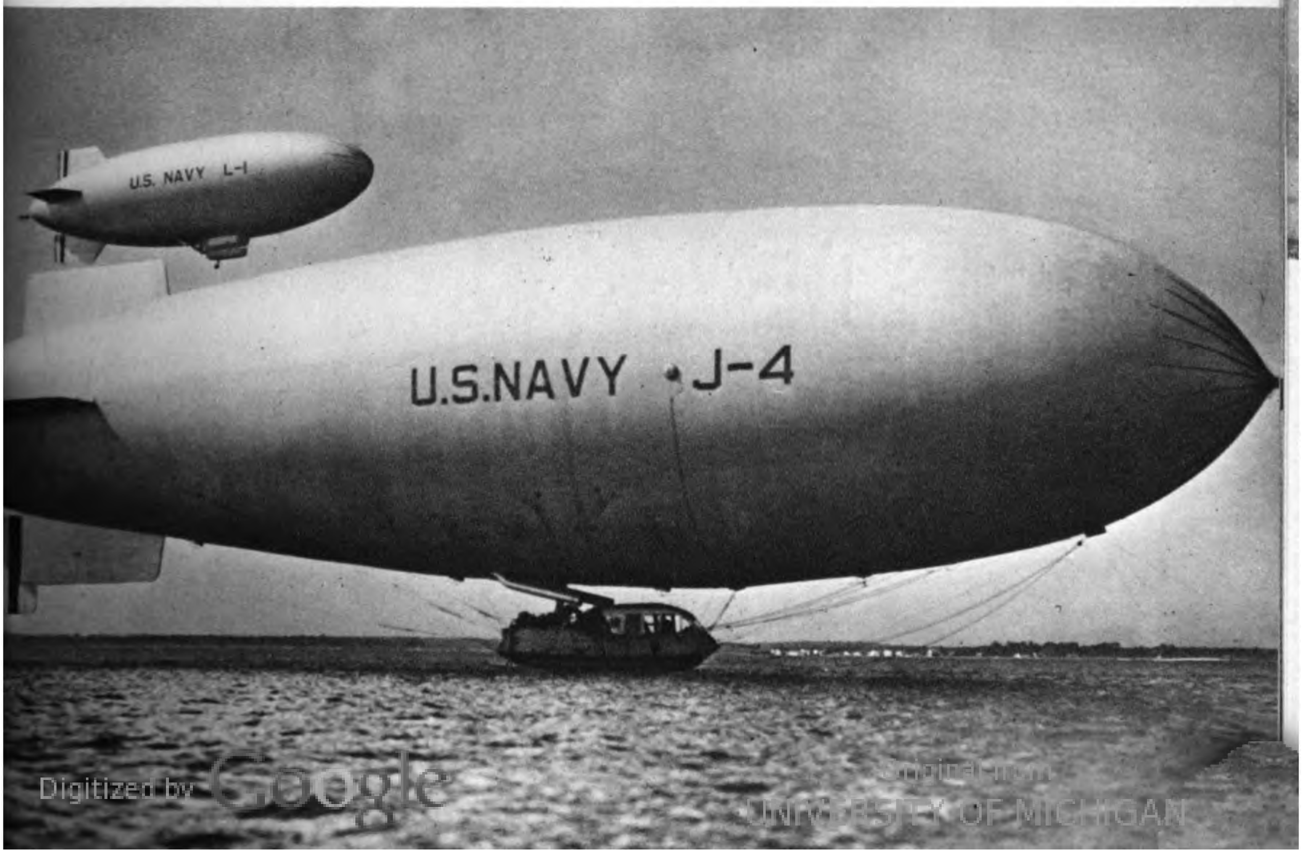
This is the Navy's first experimental blimp, the DN-1. It was built in 1917.

The C-7 was the first airship in the world to fly on helium.



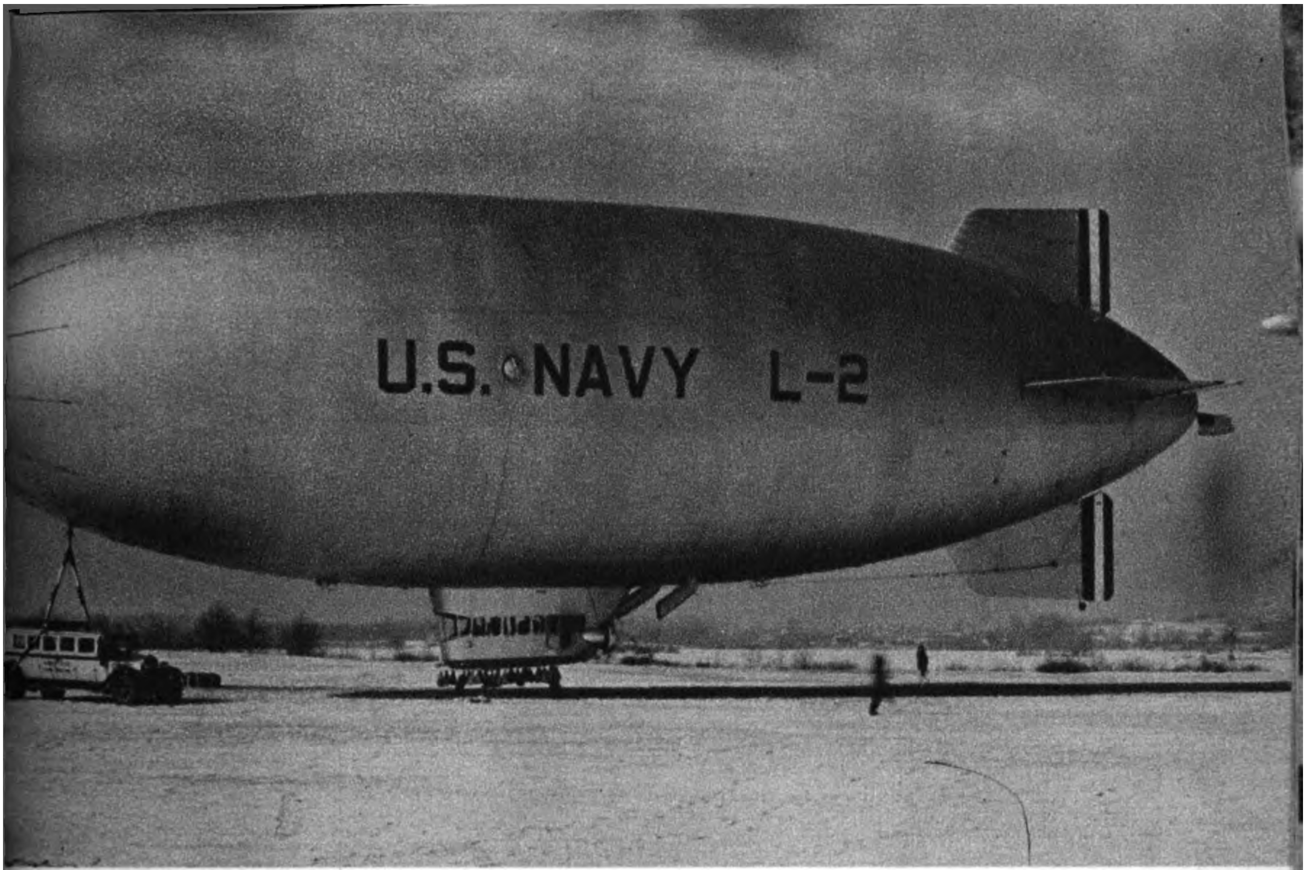
The modern trend with enclosed control car attached directly to the envelope. The use of non-inflammable helium makes this possible.

A contrast in types. The J Class is now obsolete, the L's are just coming in. Both are used for training purposes.

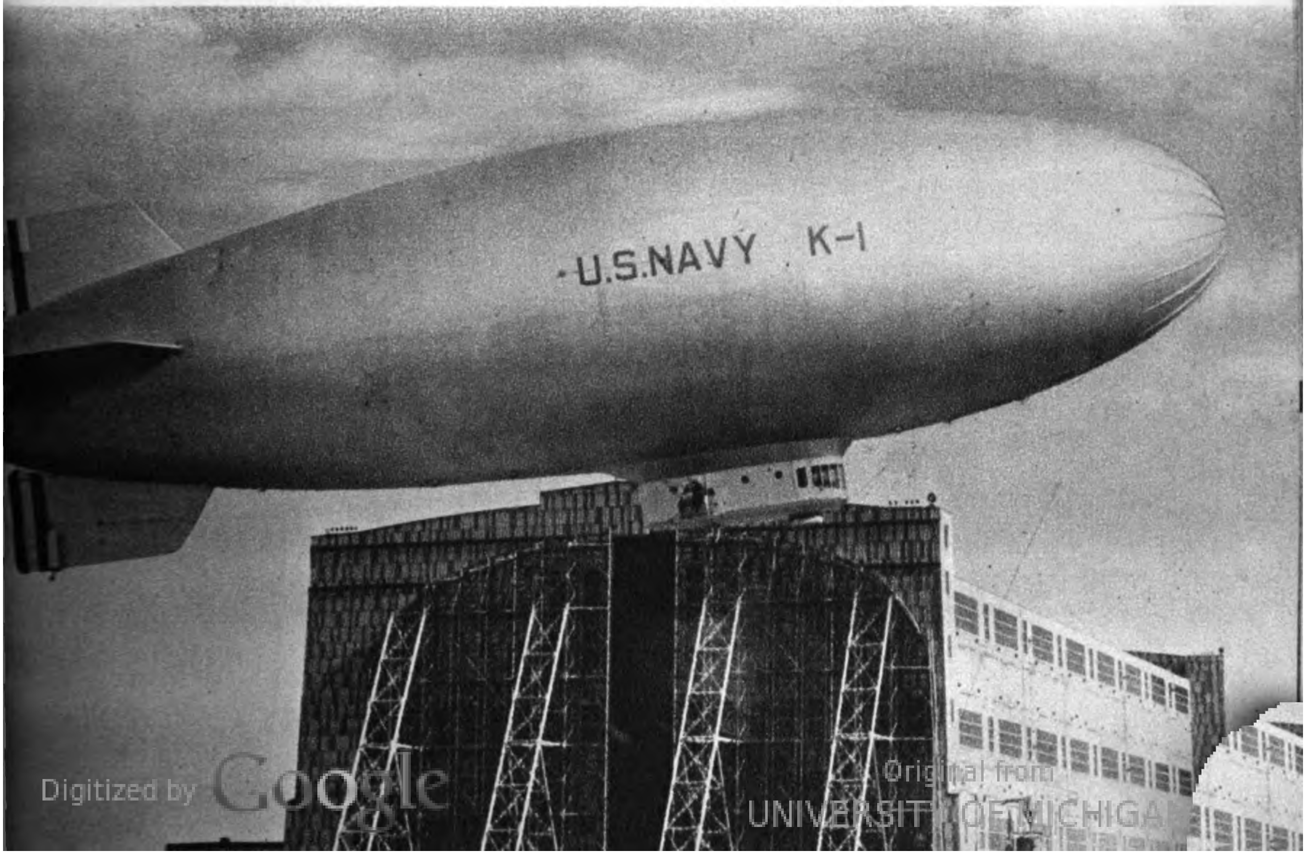


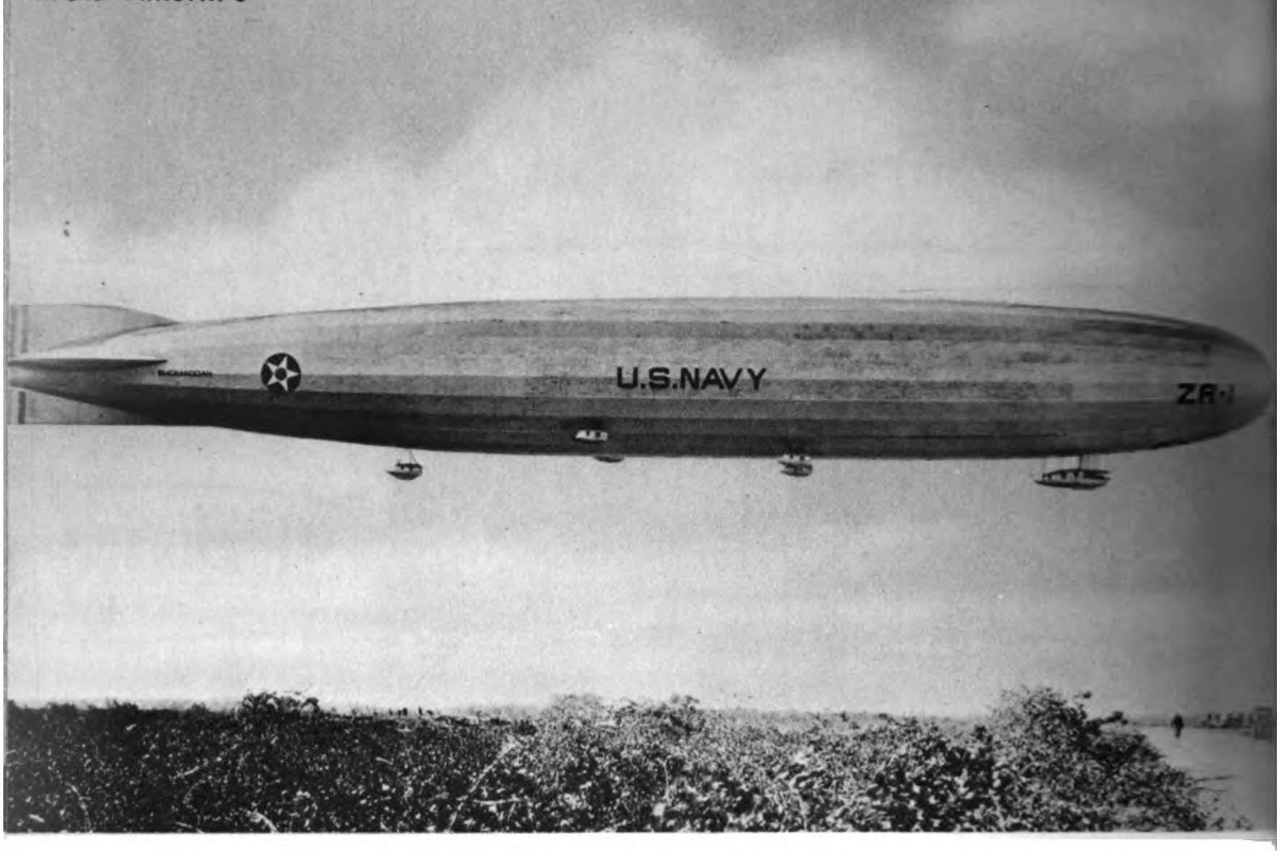
One of the two ships that were turned over to the Navy by the Army Air Corps when it abandoned lighter-than-air in 1938.

The Navy's "tin bubble." The entire envelope is made up of thin aluminum sheets. This "metal-clad" blimp has been in service over 10 years.



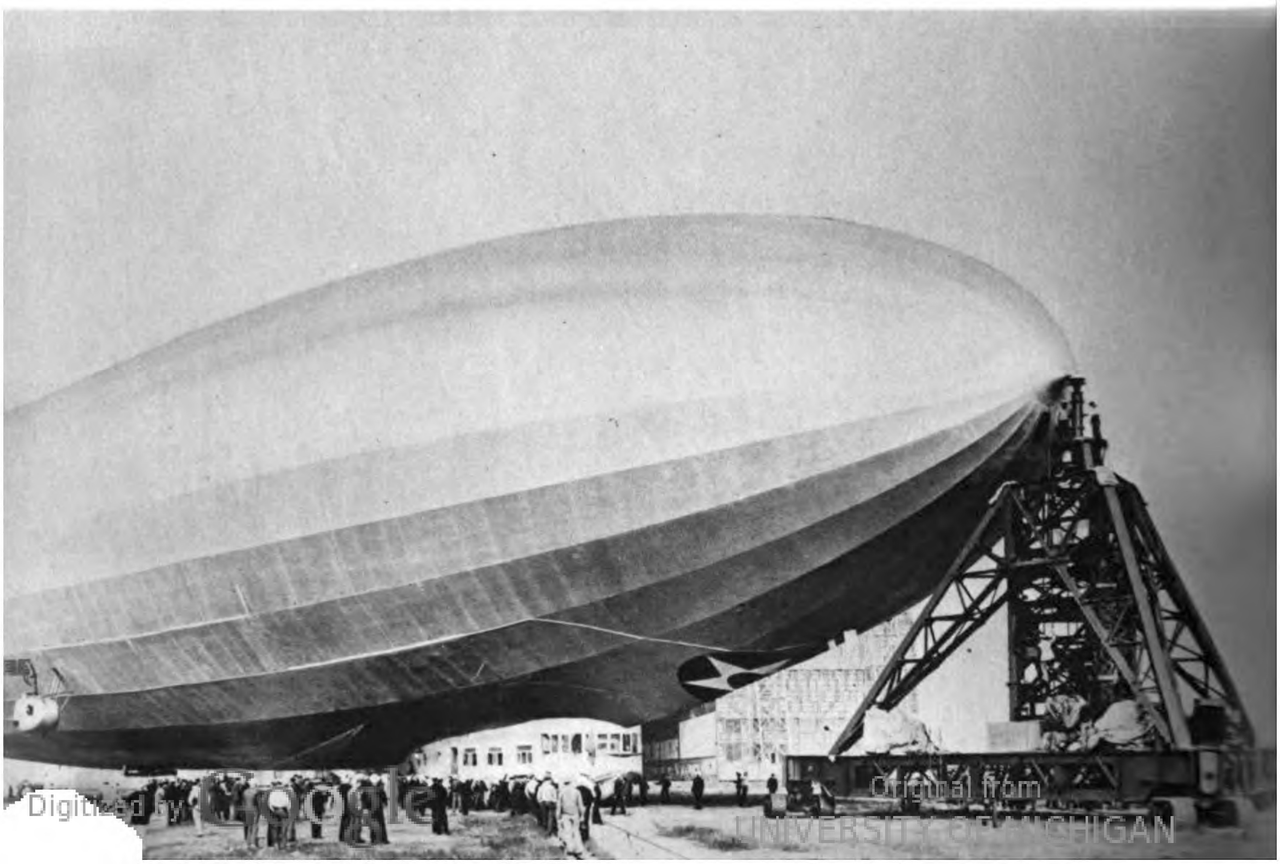
A total of 48 L and K Class ships are now being built for the Navy. The smaller L's are used chiefly for training. The K's will go on patrol duty at bases from Greenland to the South Seas.

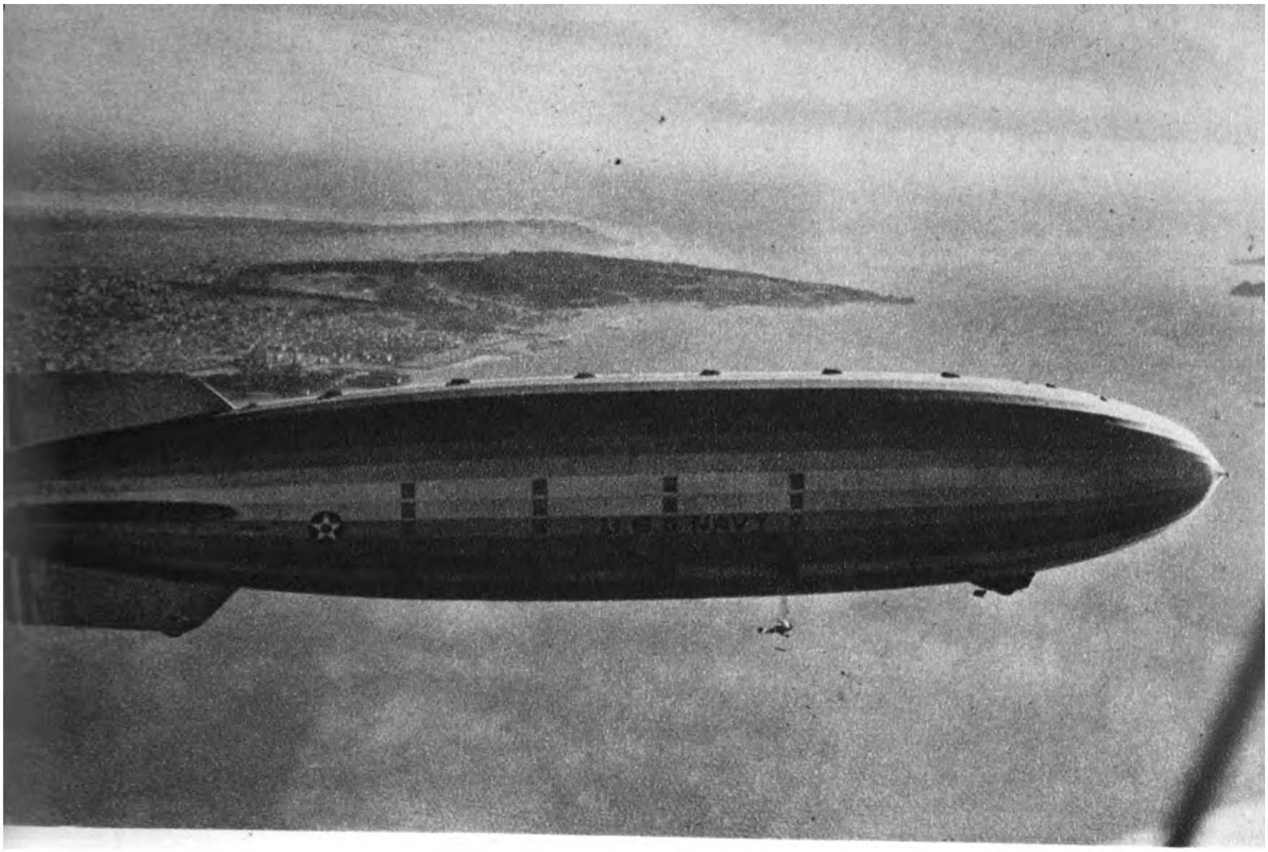




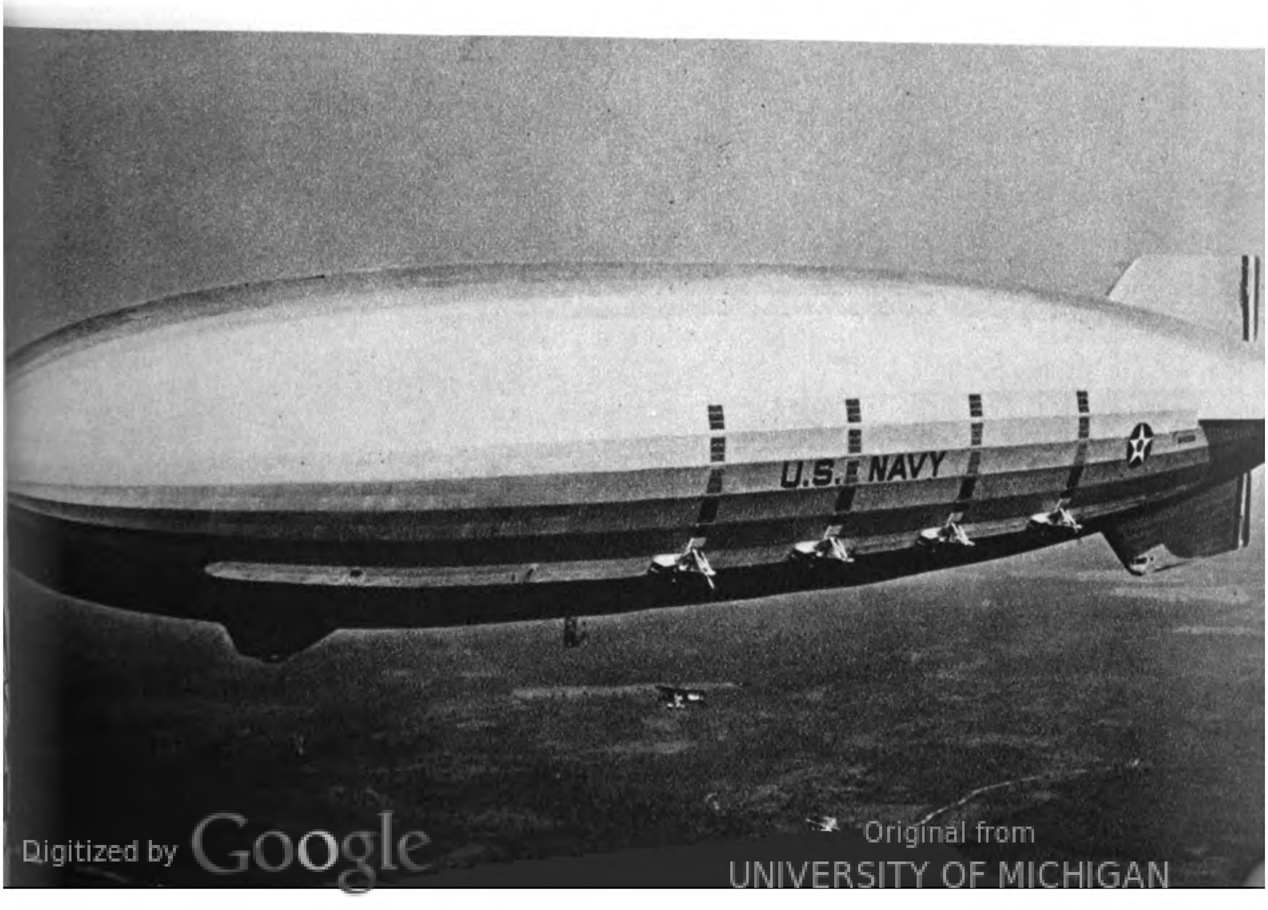
First American-built rigid airship, the *U.S.S. Shenandoah,* tied up at the Lakehurst mast.

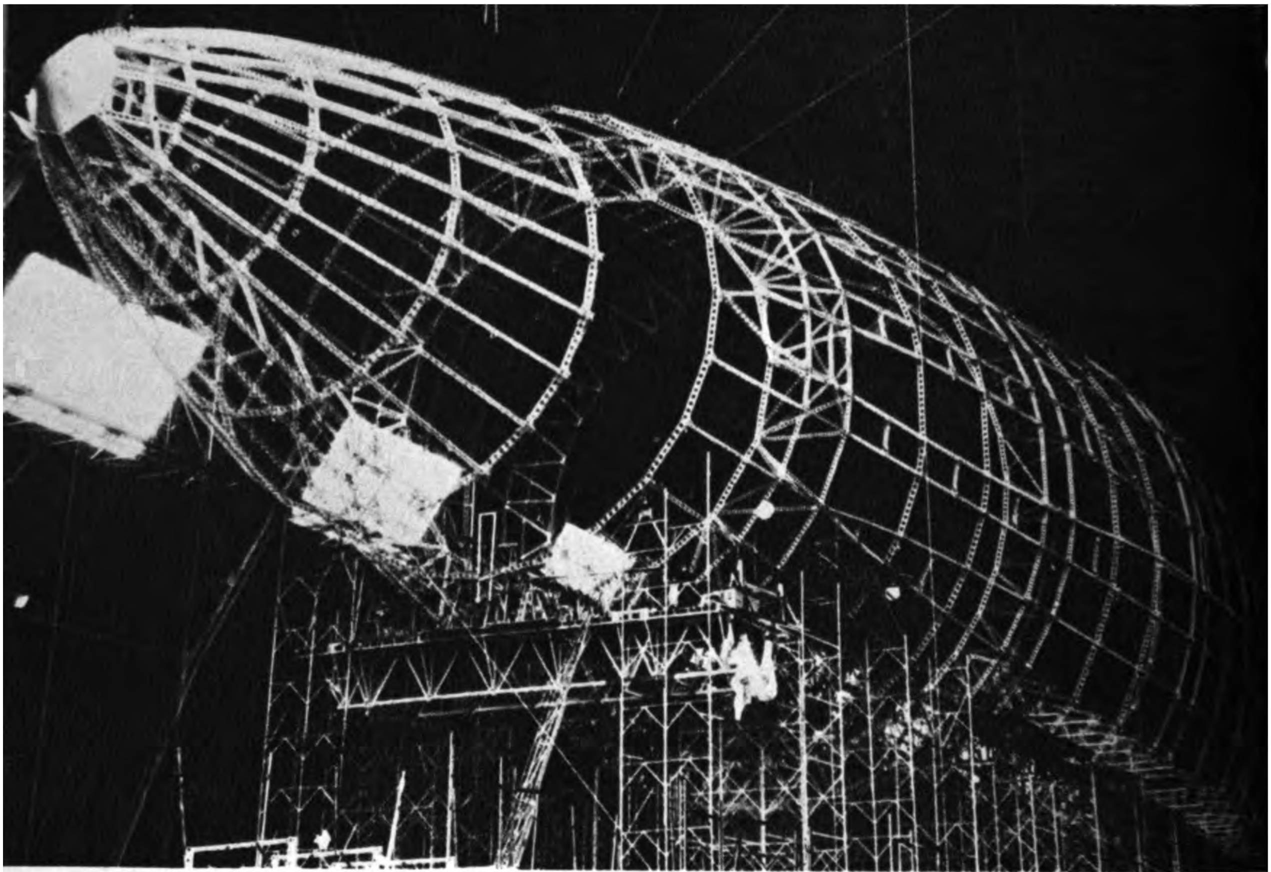
The veteran *U.S.S. Los Angeles* was built in Germany, flown to the United States in October 1924 It was scrapped in 1939.





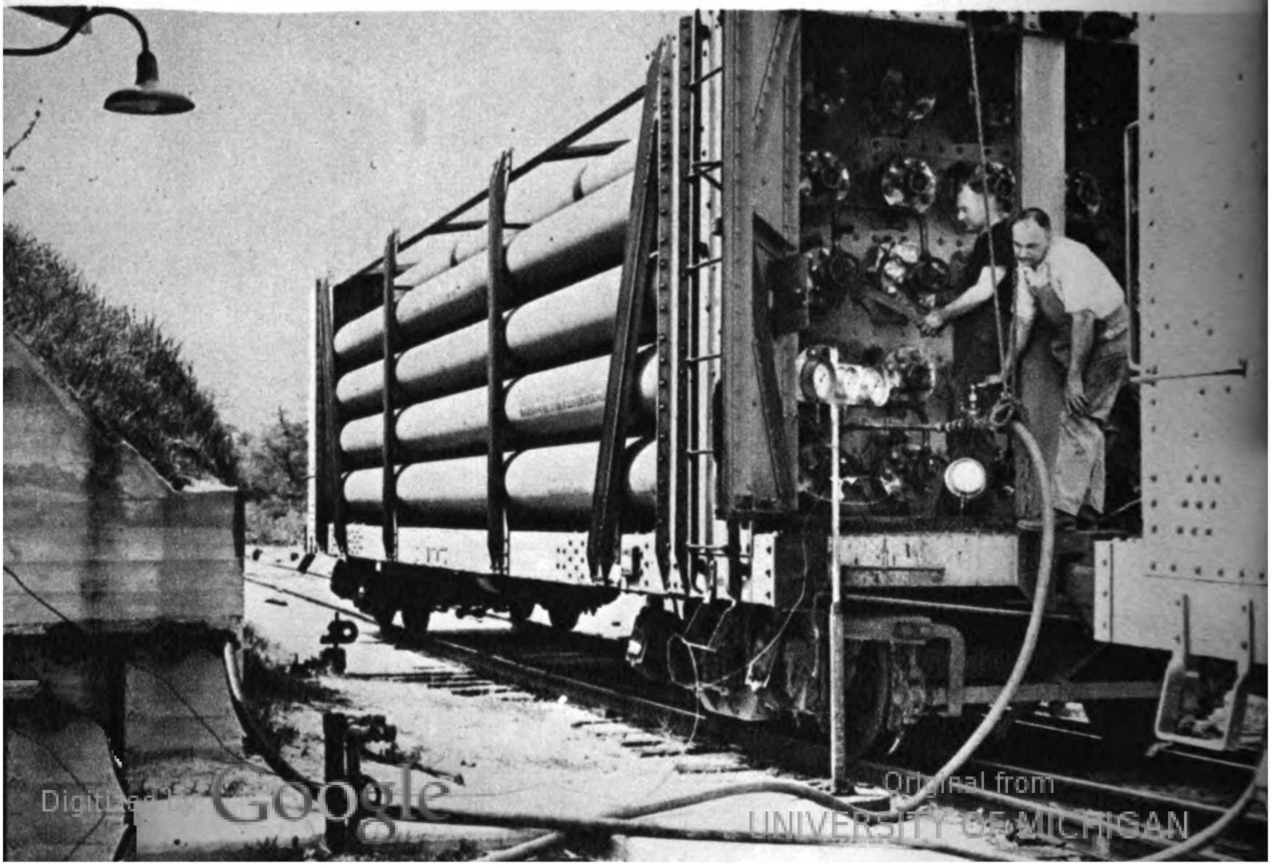
The ill-fated sister ships *U.S.S. Akron* and *U.S.S. Macon* were the largest rigid airships ever built. Note trapeze under the belly amidships for launching and retrieving fighter airplanes.



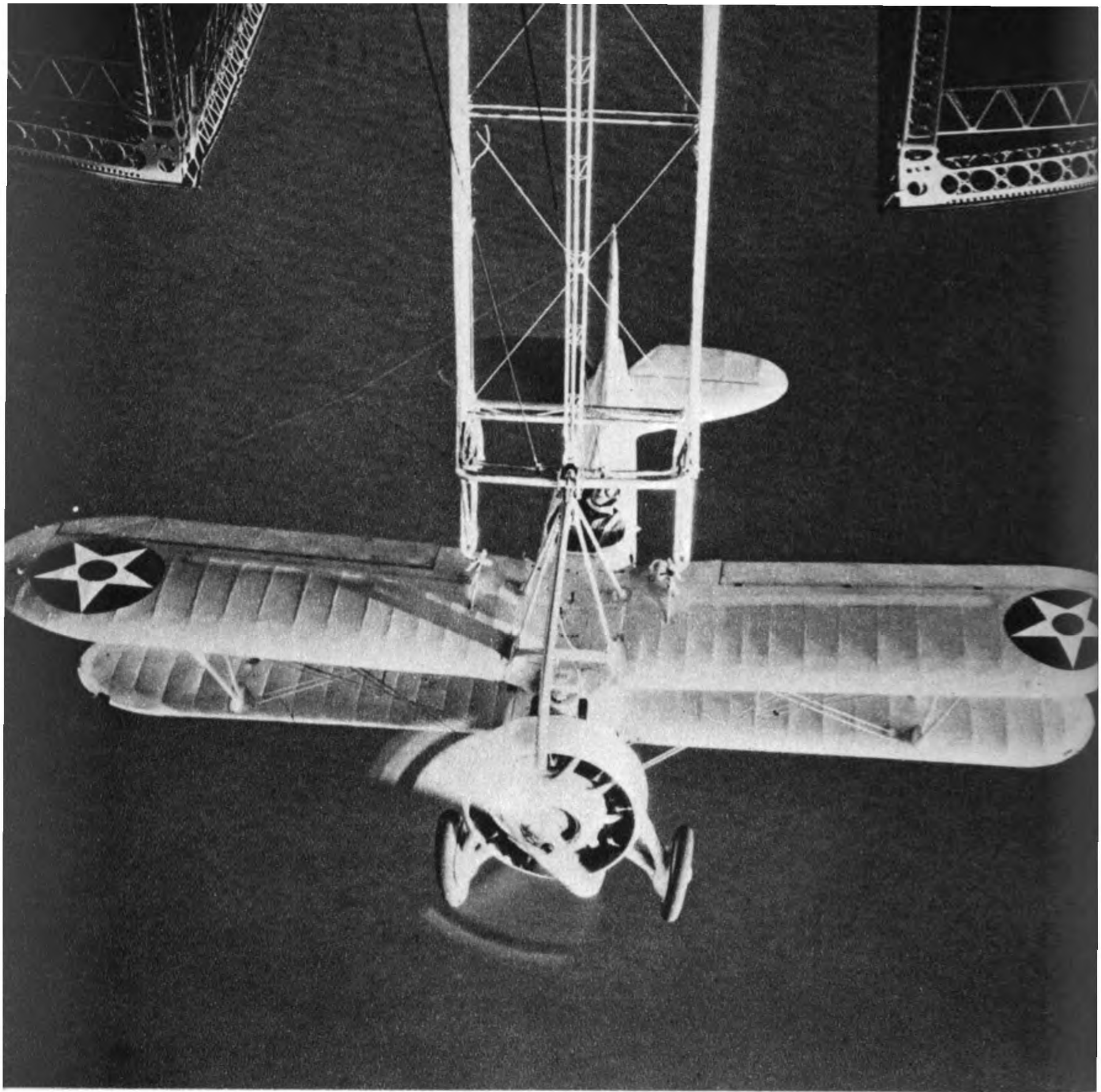


A rigid airship under construction—attaching the tail cone on the *U.S.S. Macon.* Girder skeleton was eventually fabric-covered.

Compressed lifting gas is handled in and distributed from special tank cars. This one handles hydrogen.



Naval Air Station at Lakehurst, New Jersey, with the *Hindenburg* at the mobile mast. The circles are railroad tracks to handle docking gear for large airships. The runways are for the use of navy airplanes.



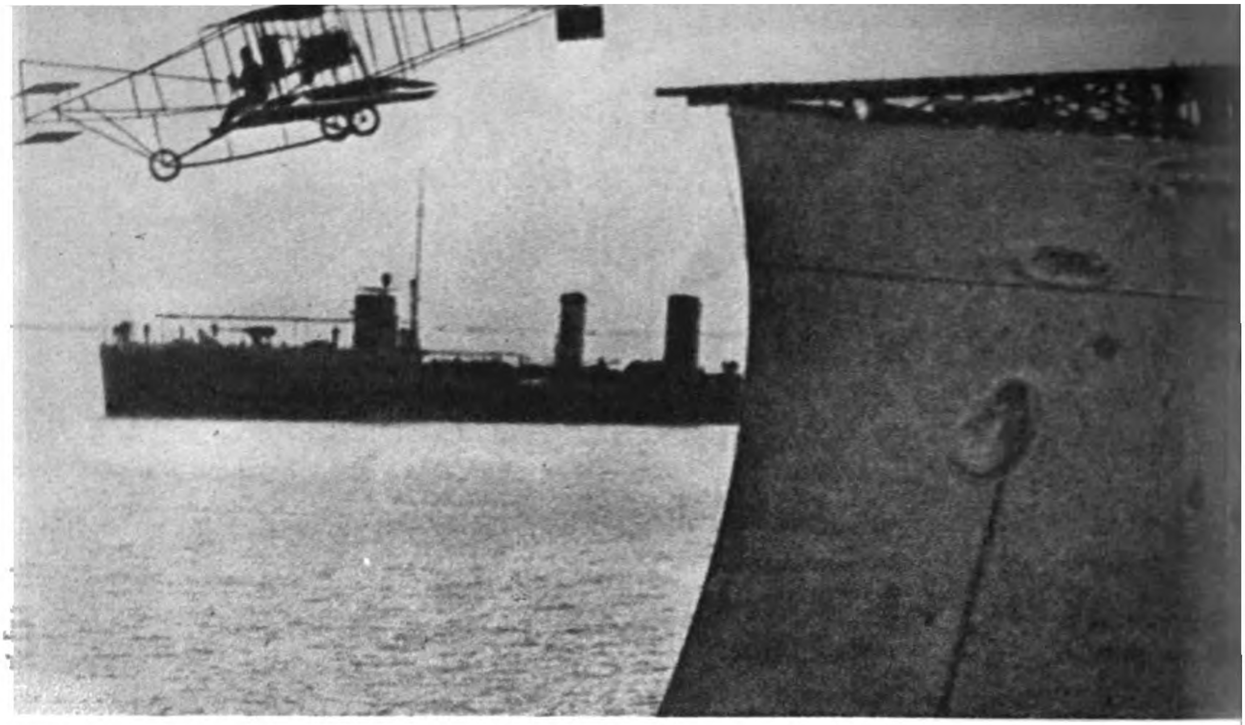
On the trapeze—an XF9C-1 fighter is being hoisted aboard the *U.S.S. Macon.*

HEAVIER THAN AIR

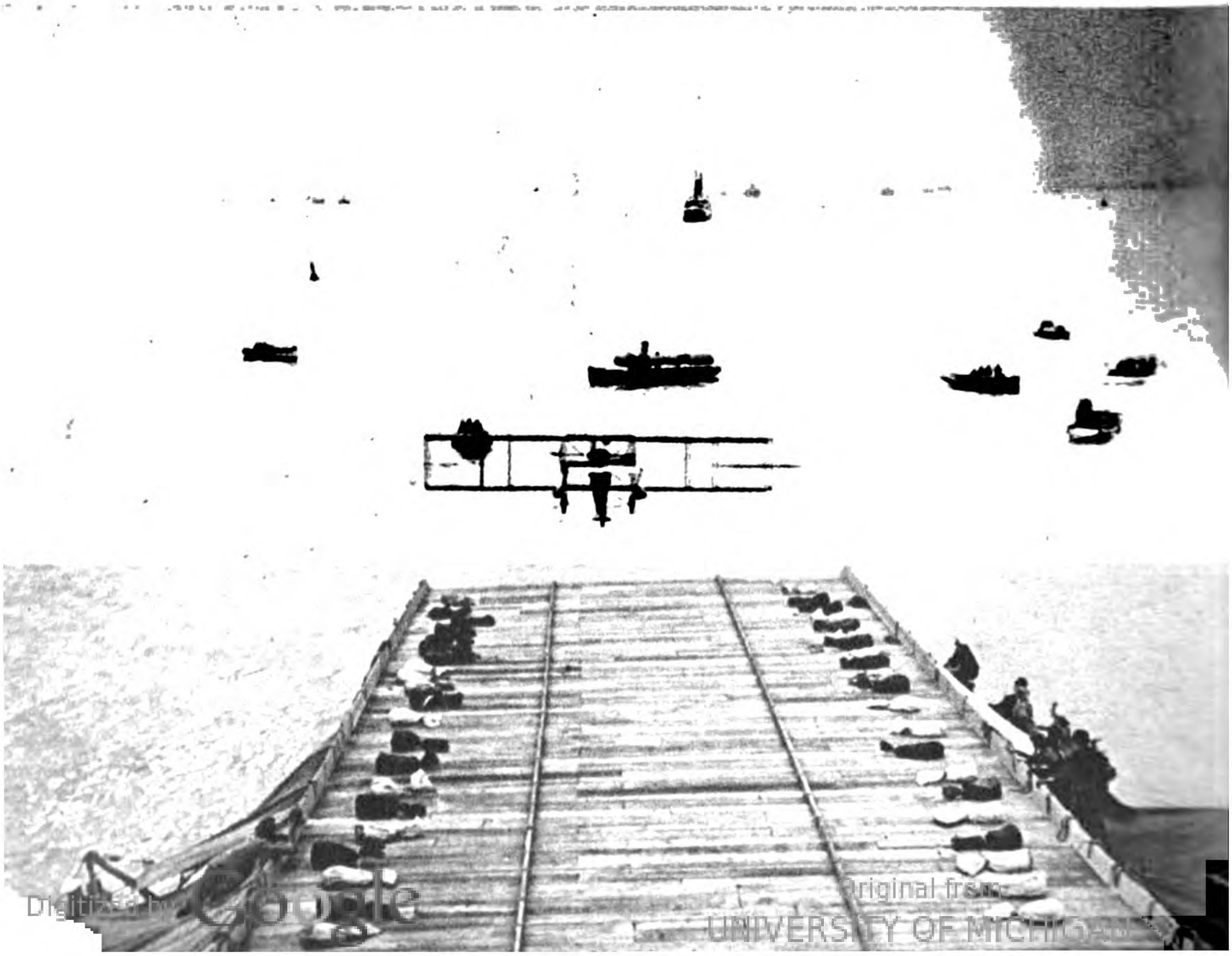
I. Ely's Flights

II. Early Hydros

From Curtiss' North Island experiments
to the War of 1917



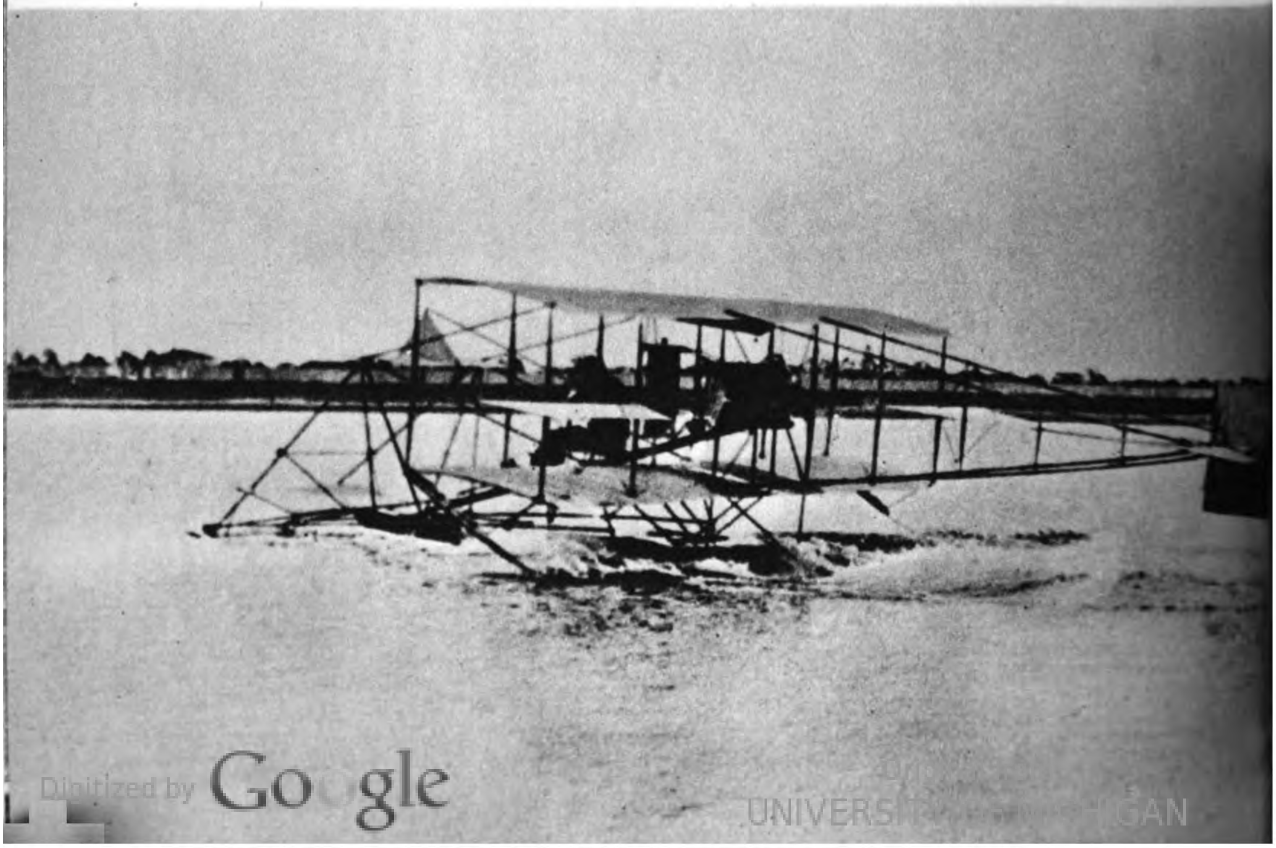
The Navy's first experiments with the airplane. *Above:* Eugene Ely takes off from the deck of the *U.S.S. Birmingham* November 14, 1910, in Hampton Roads. *Below:* Ely coming in to land on the after-deck of the *U.S.S. Pennsylvania* on January 18, 1911, at San Francisco. Note sand bags and cables used for arresting gear.

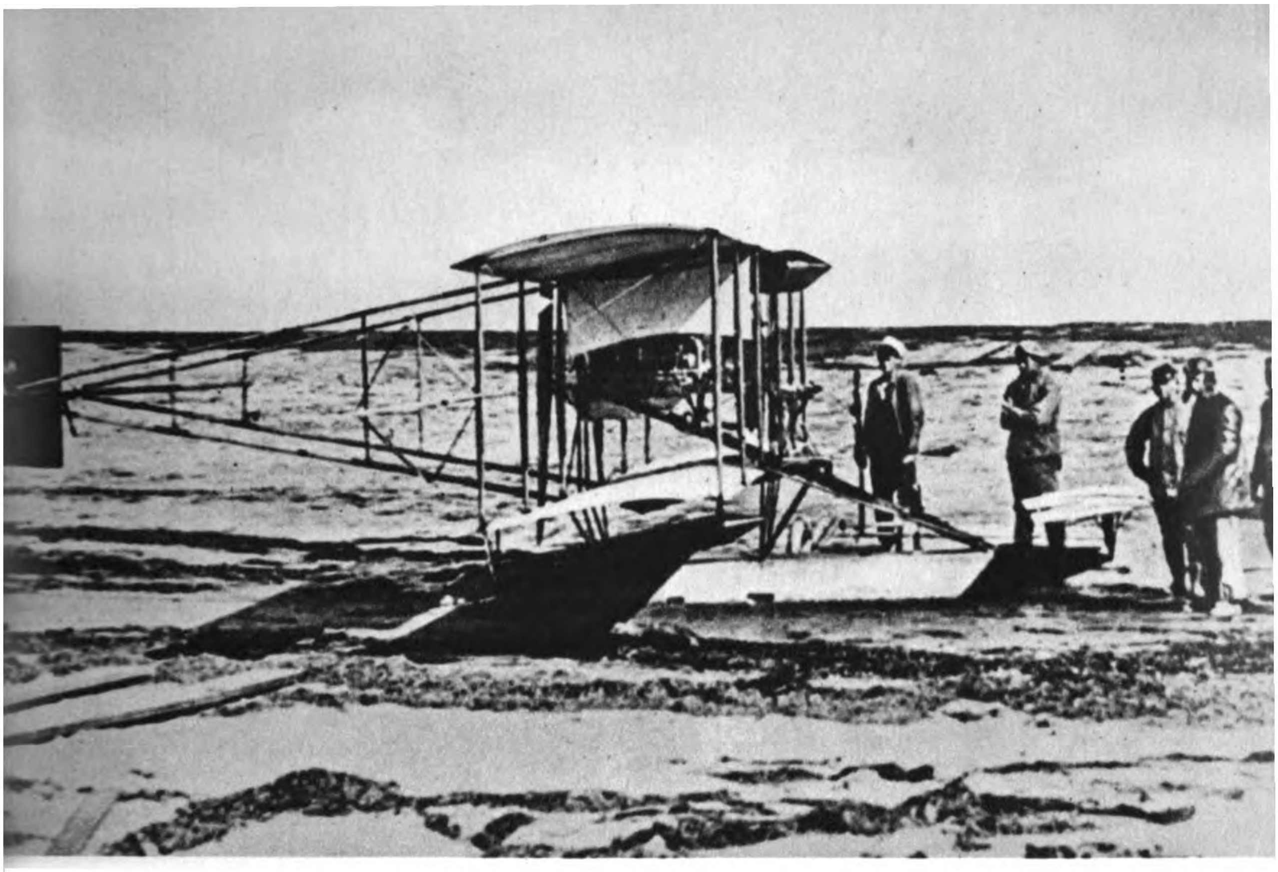


No Man from Mars—Eugene Ely wearing a crash helmet, home-made floatation gear, and a grim expression, about to take off from the *Pennsylvania's* deck for the return trip to the *Presidio*, San Francisco, January 18, 1911.

I. EUGENE ELY'S PIONEERING FLIGHTS

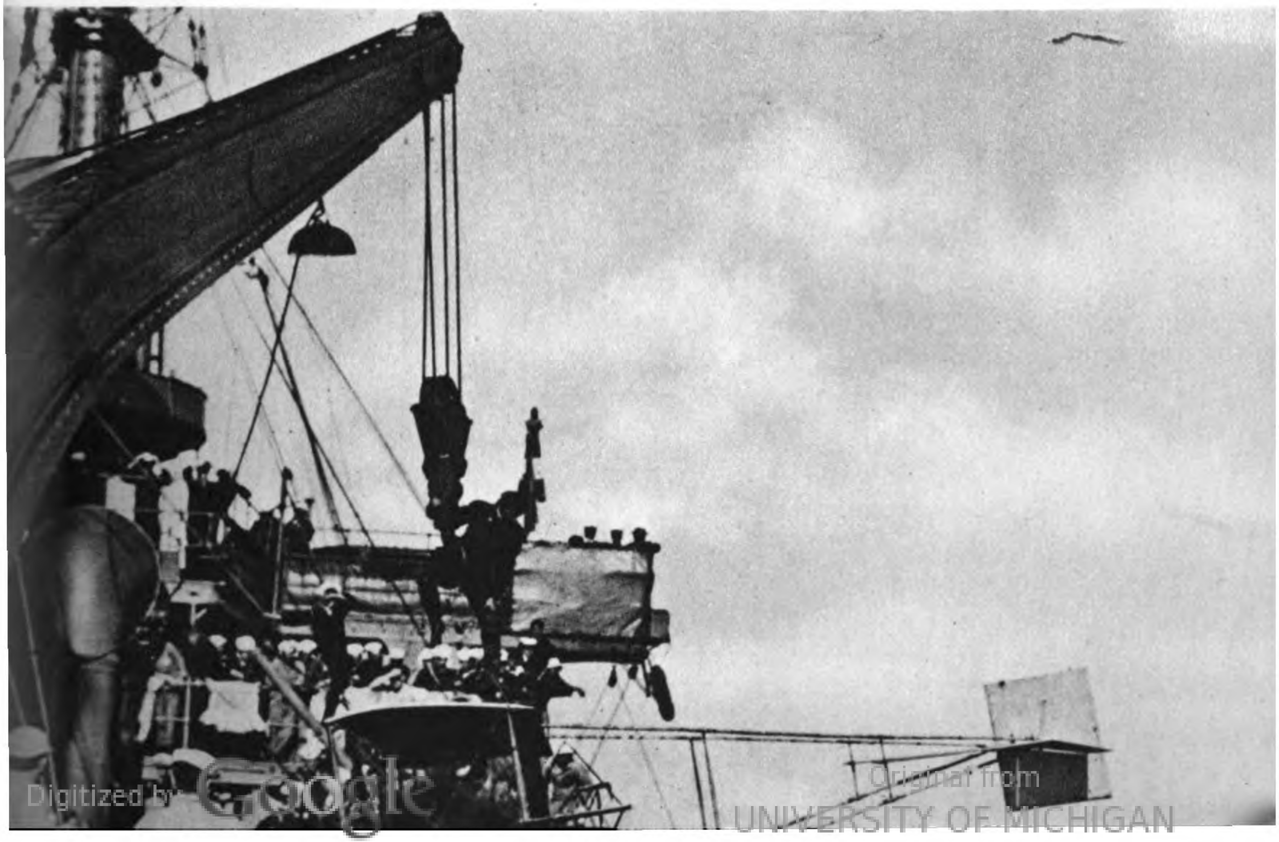
One of the unsuccessful attempts to get a hydro off the water from Curtiss' North Island (San Diego) base in January 1911.





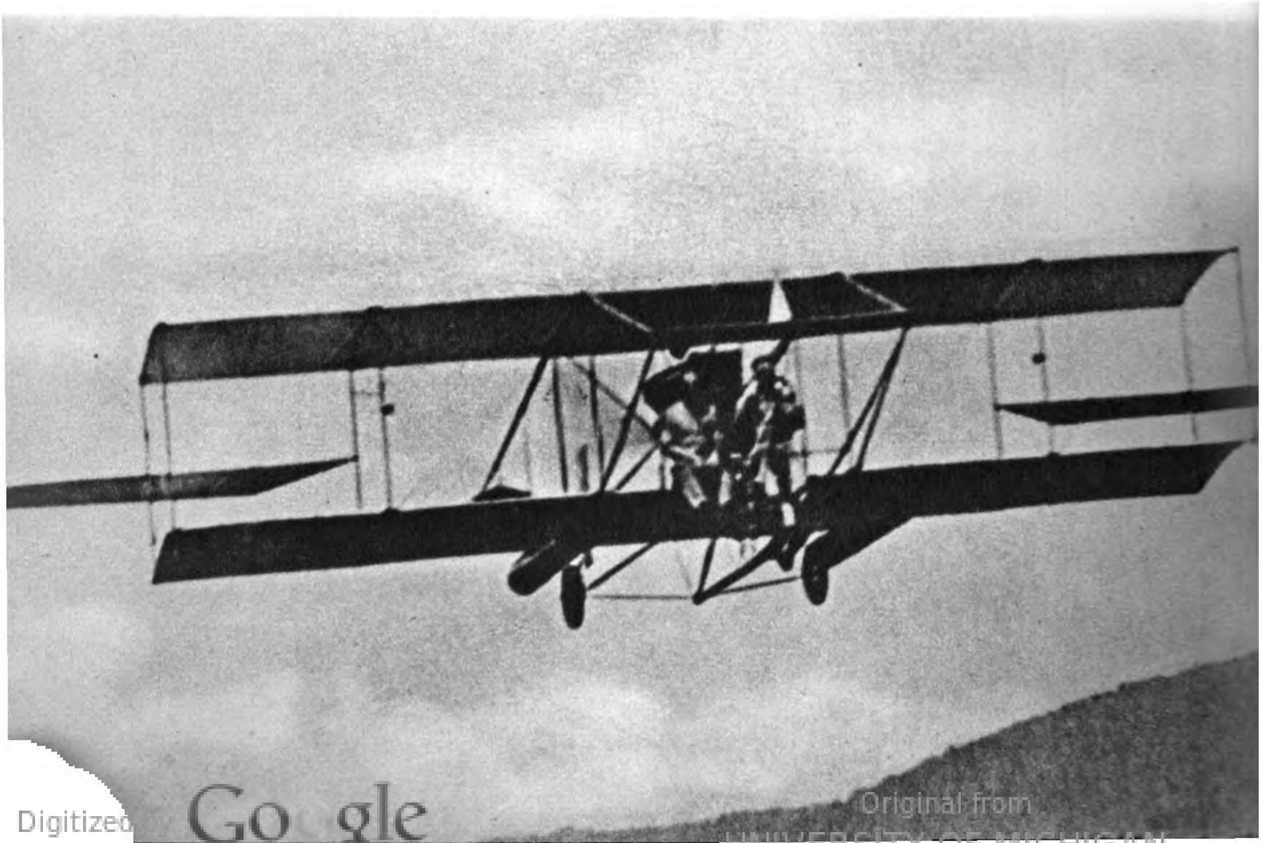
The Navy's first seaplane, the successful Curtiss hydro of February 1911.

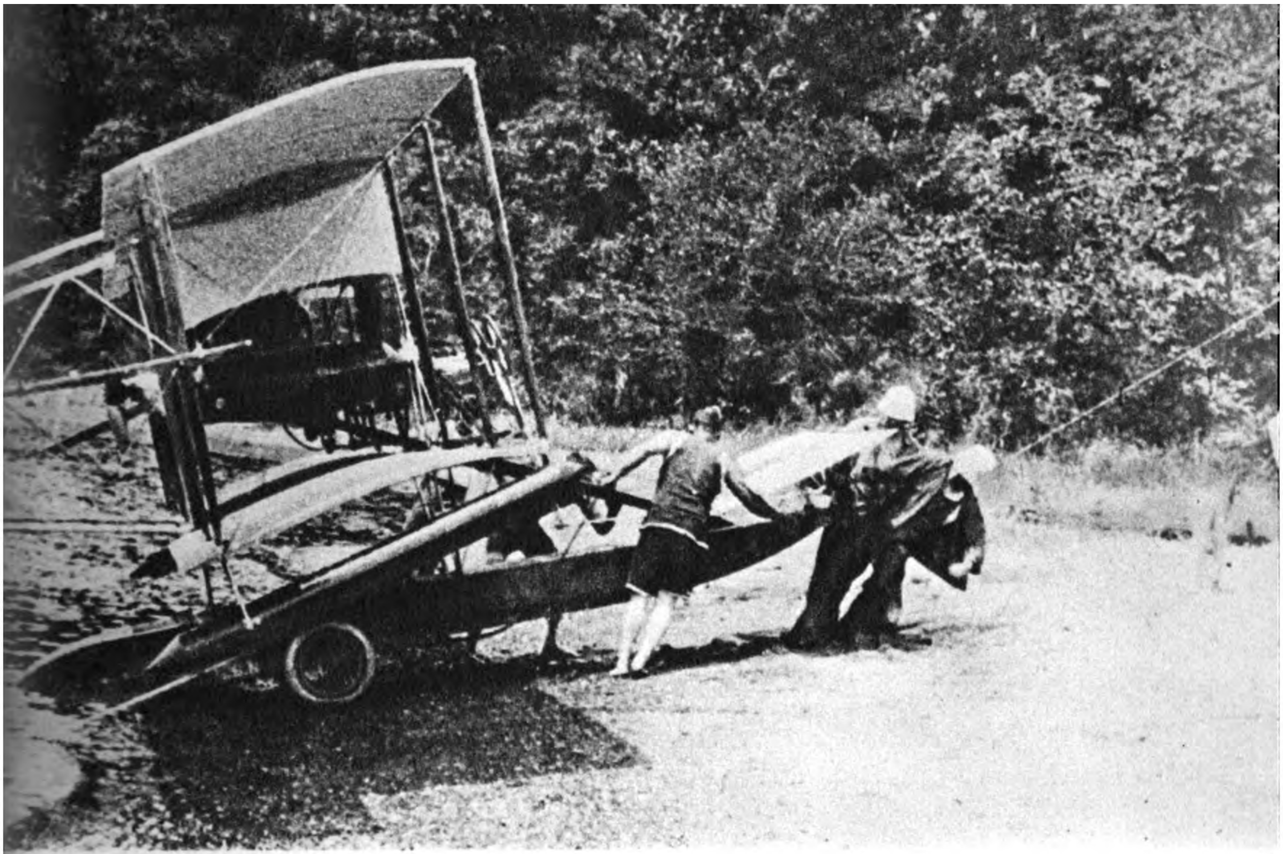
Glenn Curtiss goes aboard the *U.S.S. Pennsylvania* off San Diego on February 17, 1911.



The Navy's first pilot—Lieutenant T. S. Ellyson, U.S.N., learned to fly on an early Curtiss pusher.

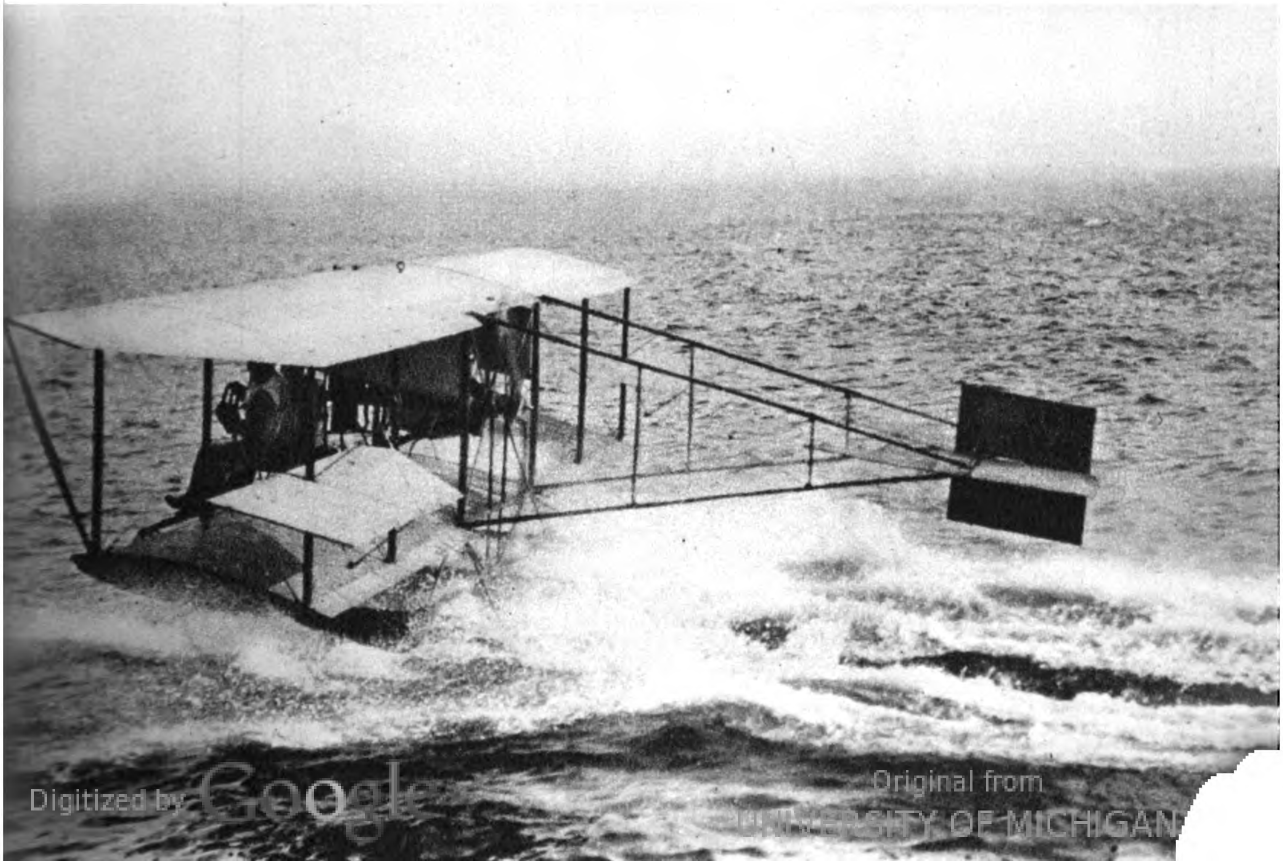
Lieutenant Ellyson and Lieutenant (now Rear Admiral) John H. Towers making a practice flight on a Curtiss pusher at Hammondsport in August 1911.

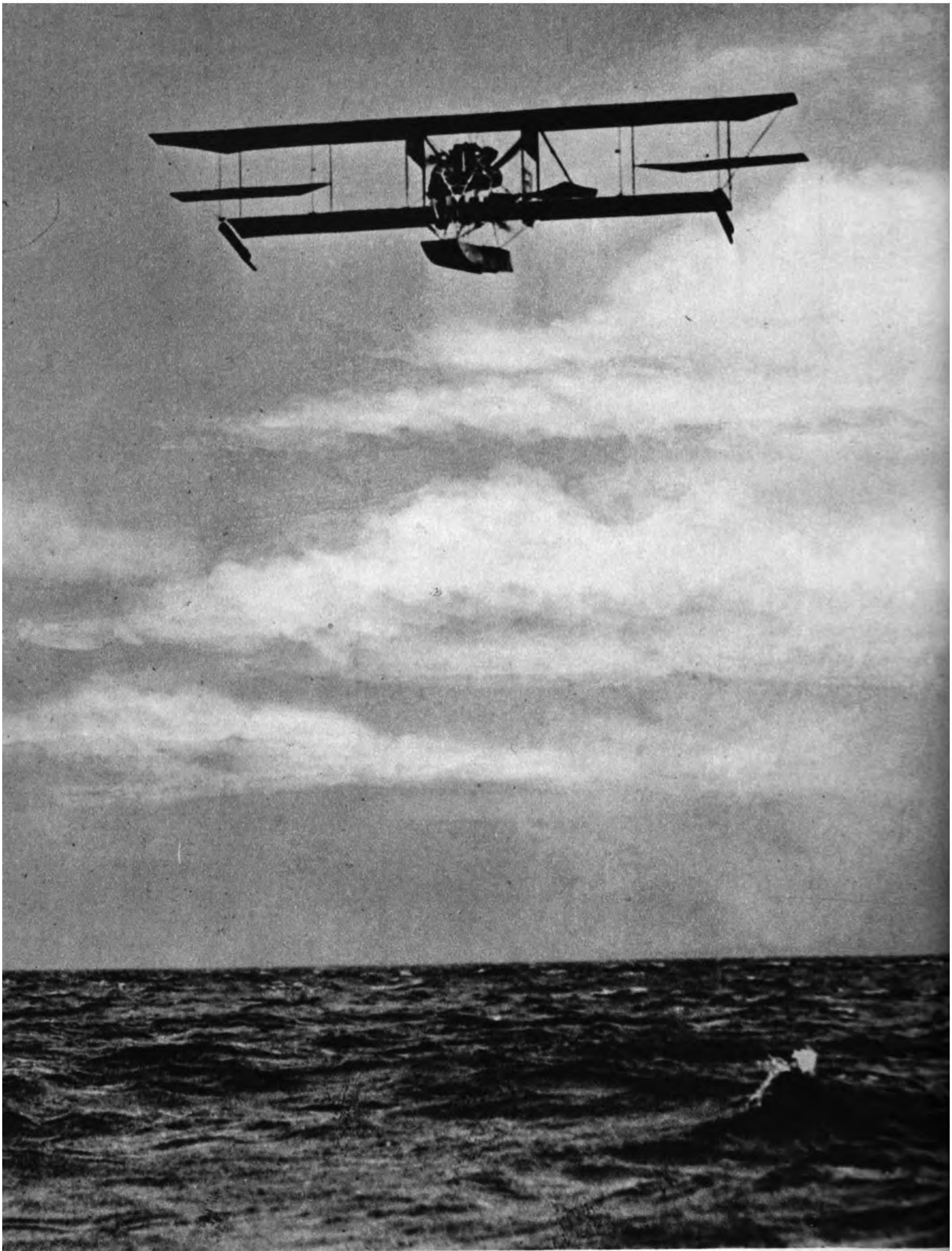




Such was life in the Curtiss flying school in 1912—beaching a hydro.

Contrast this Navy seaplane of 1913 with the modern scout in the next section of photographs.



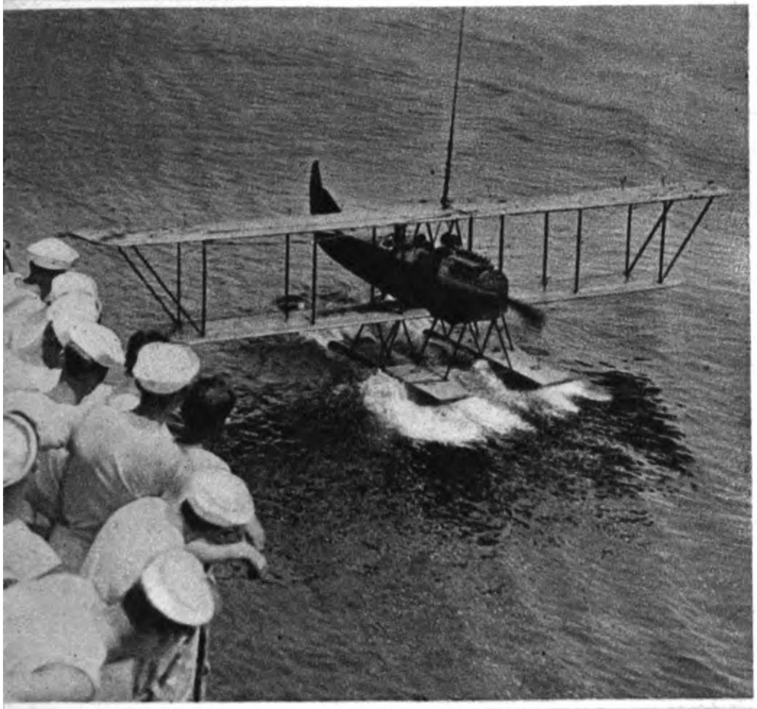


As late as 1914 this was a standard U.S. naval airplane. Note flat-bottomed float, interplane ailerons, exposed dual controls.

HEAVIER THAN AIR

Seaplanes

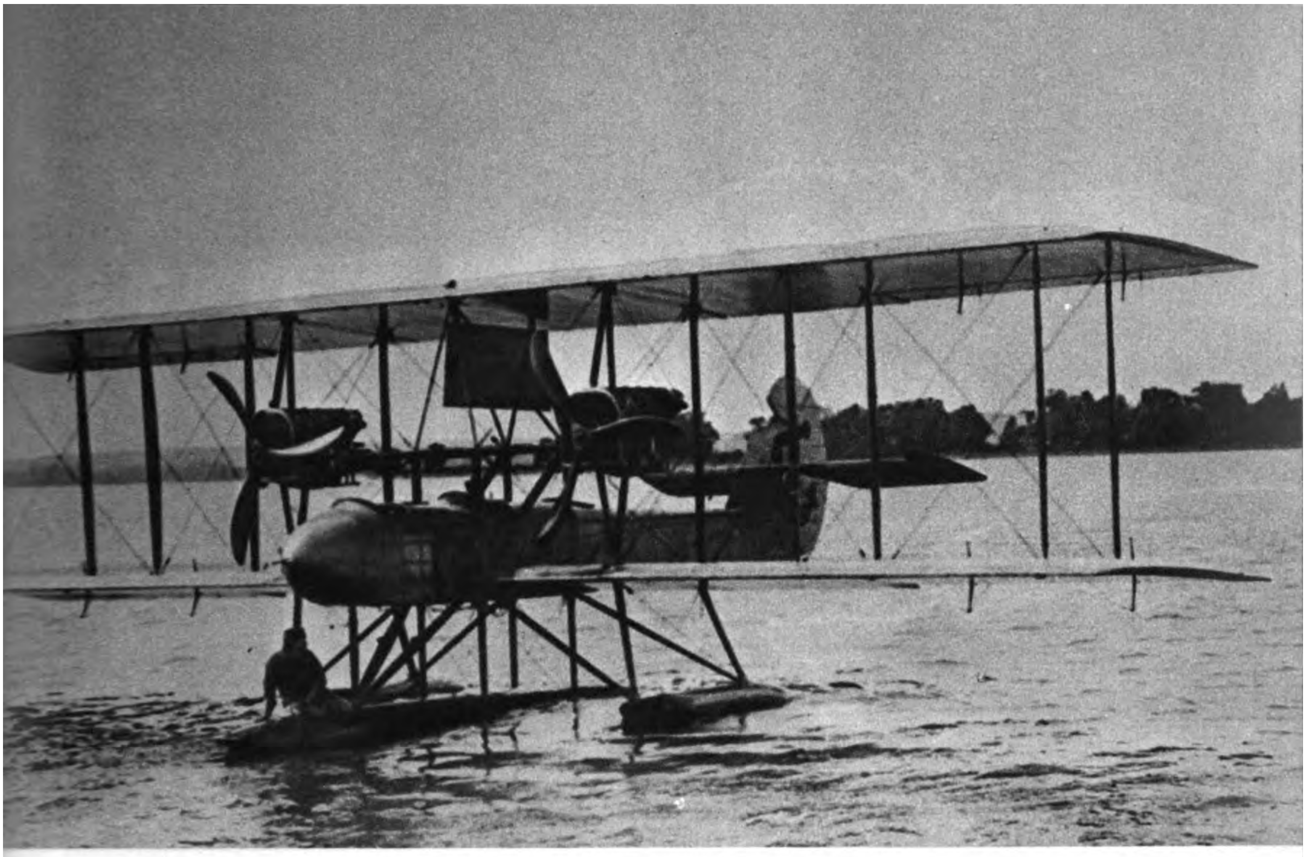
From World War I to World War II



The N-9 Naval Training airplane of 1916 with Curtiss OX-5 engine. (*Courtesy Curtiss-Wright*)

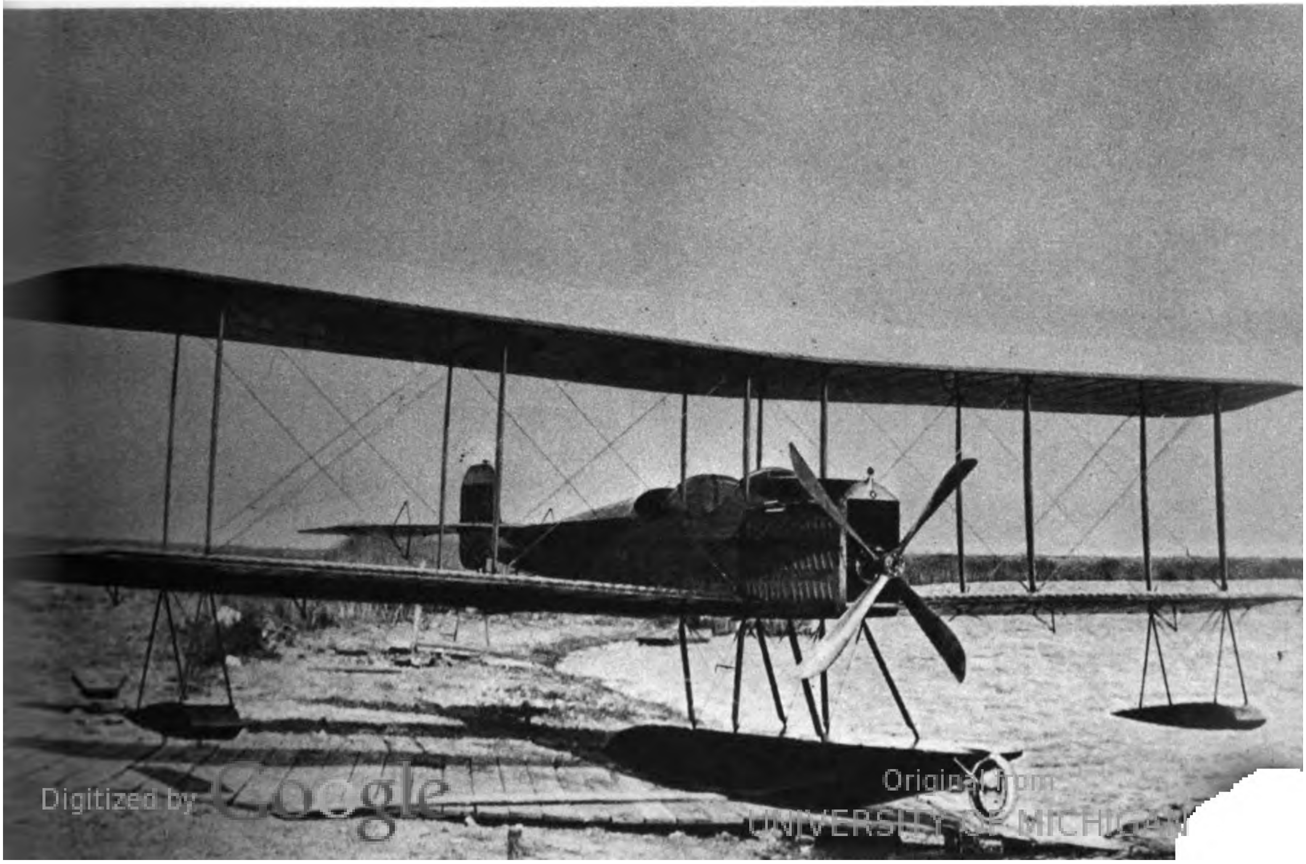
A Burgess tractor goes over the side of the *U.S.S. Huntington*, June 1917. (*Courtesy Aviation Magazine*)

Fifty of these C type trainers with Hall-Scott engines were built by Boeing for the Navy in 1918. (*Courtesy Boeing Airplane Co.*)



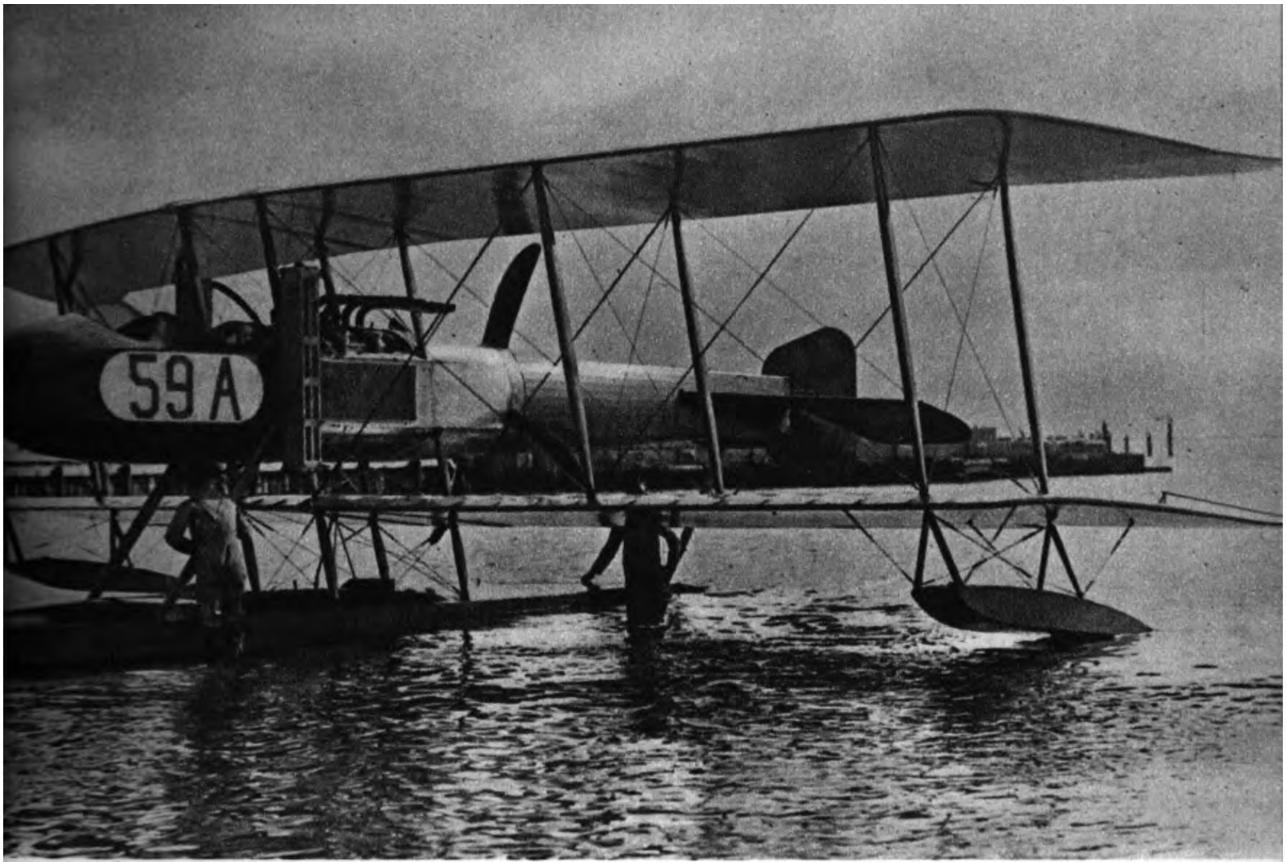
First Navy-built airplane, the Richardson twin tractor of 1915.

Glenn Martin built a number of these Model TA 100 horsepower machines for the United States and for Holland in 1915-16. (*Courtesy Glenn L. Martin Company*)



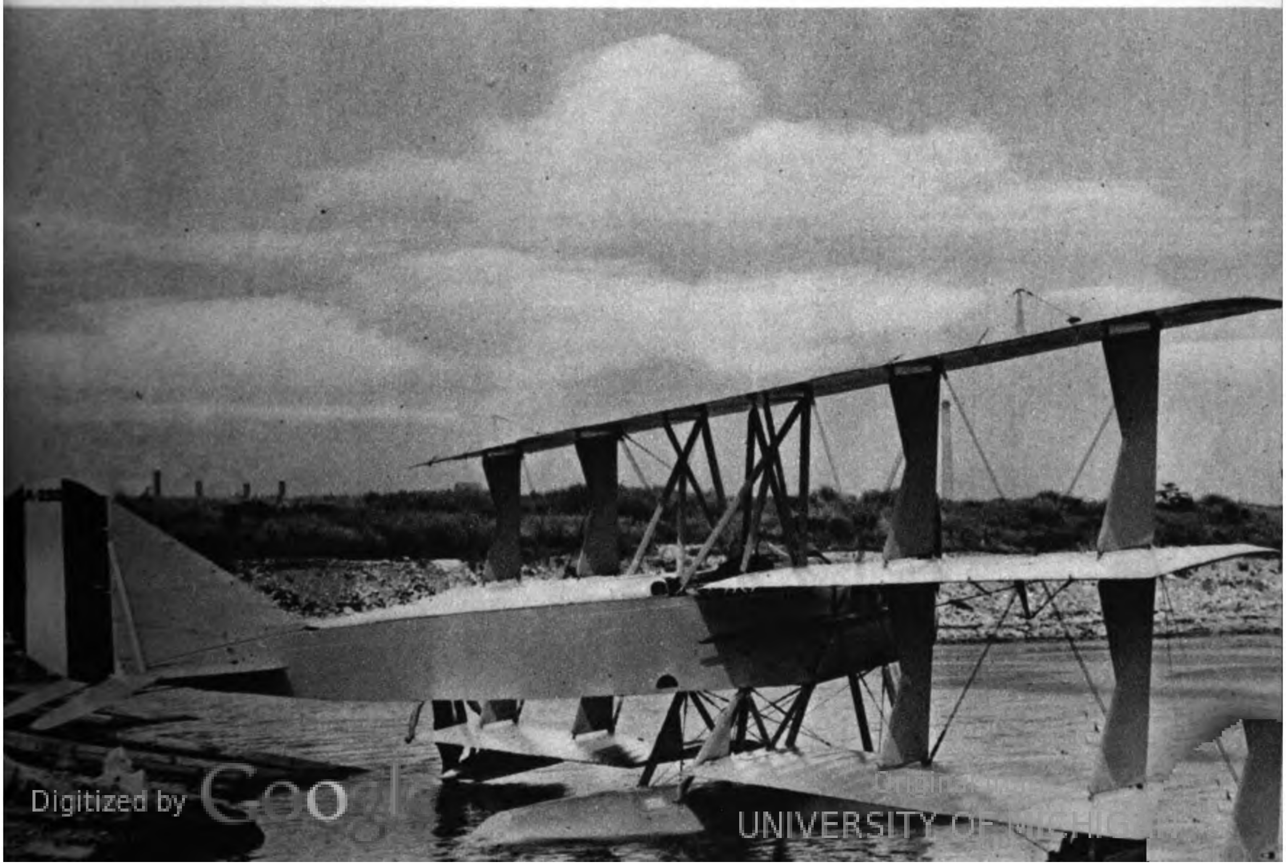
An experimental tailless hydro of 1912—the Burgess-Dunn seaplane. It flew successfully but was never adopted as a service type.

An experimental Wright hydro of about 1915. Note twin tractor propellers.



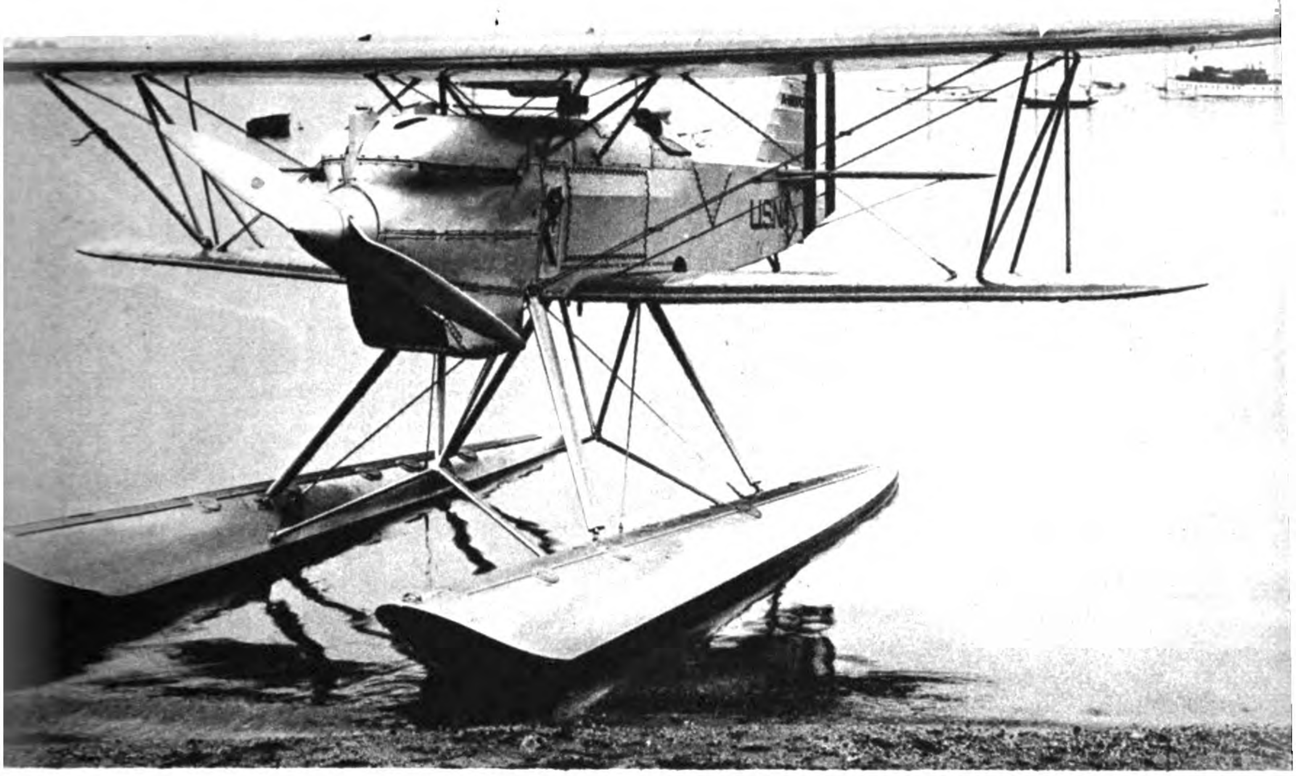
The Gallaudet experimental pusher had its propeller mounted in the middle of the fuselage behind the pilots.

An experimental triplane of 1918 that never went into production—the Curtiss L-2 with OX-5 motor.



The Navy's first all-metal seaplane, the pint-size Martin MS-1 of 1923. (*Courtesy Glenn L. Martin Company*)

The Navy's version of the VE-7, standard Army fighter of 1922.



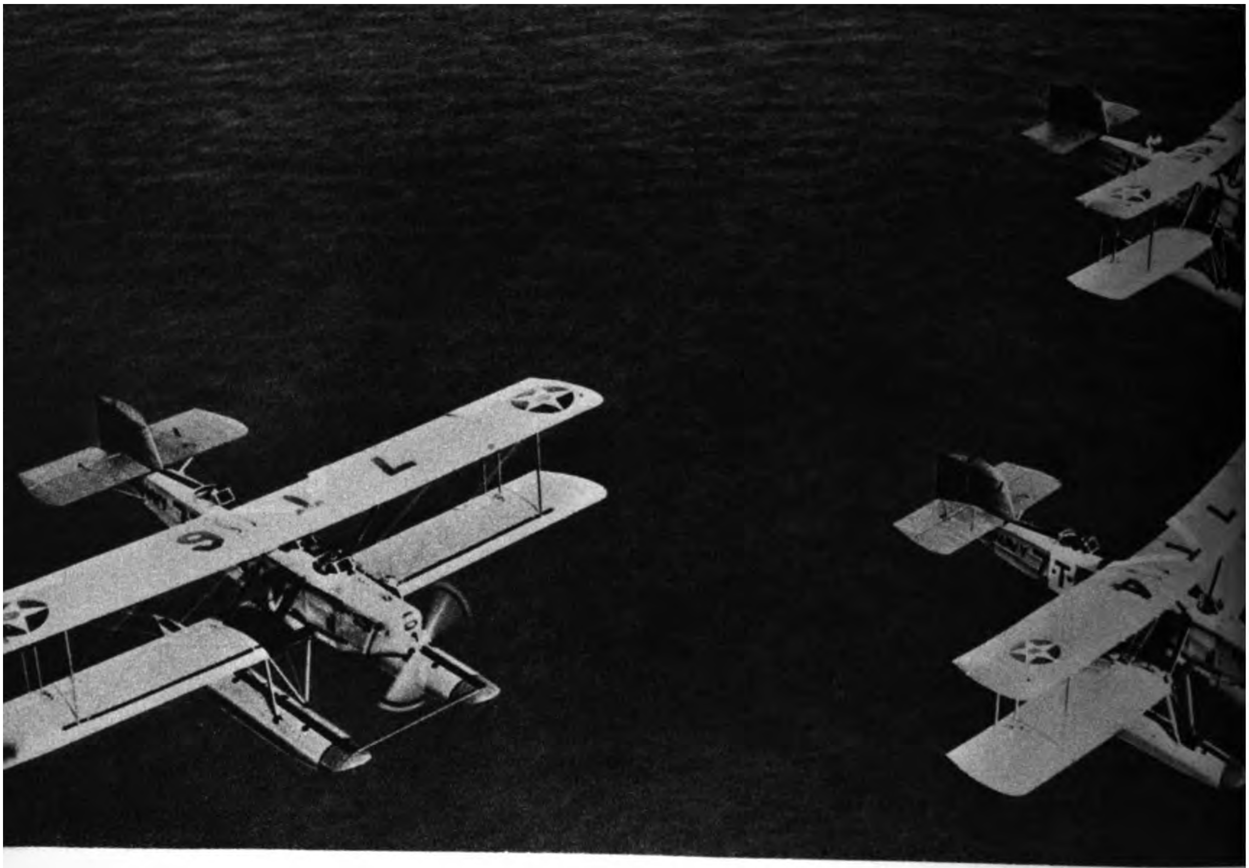
This business-like fighter, the Curtiss Hawk seaplane, appeared in the Navy in 1925. (*Courtesy Curtiss-Wright*)

One of the earliest air-cooled Navy jobs was the Curtiss TS fighter seaplane.

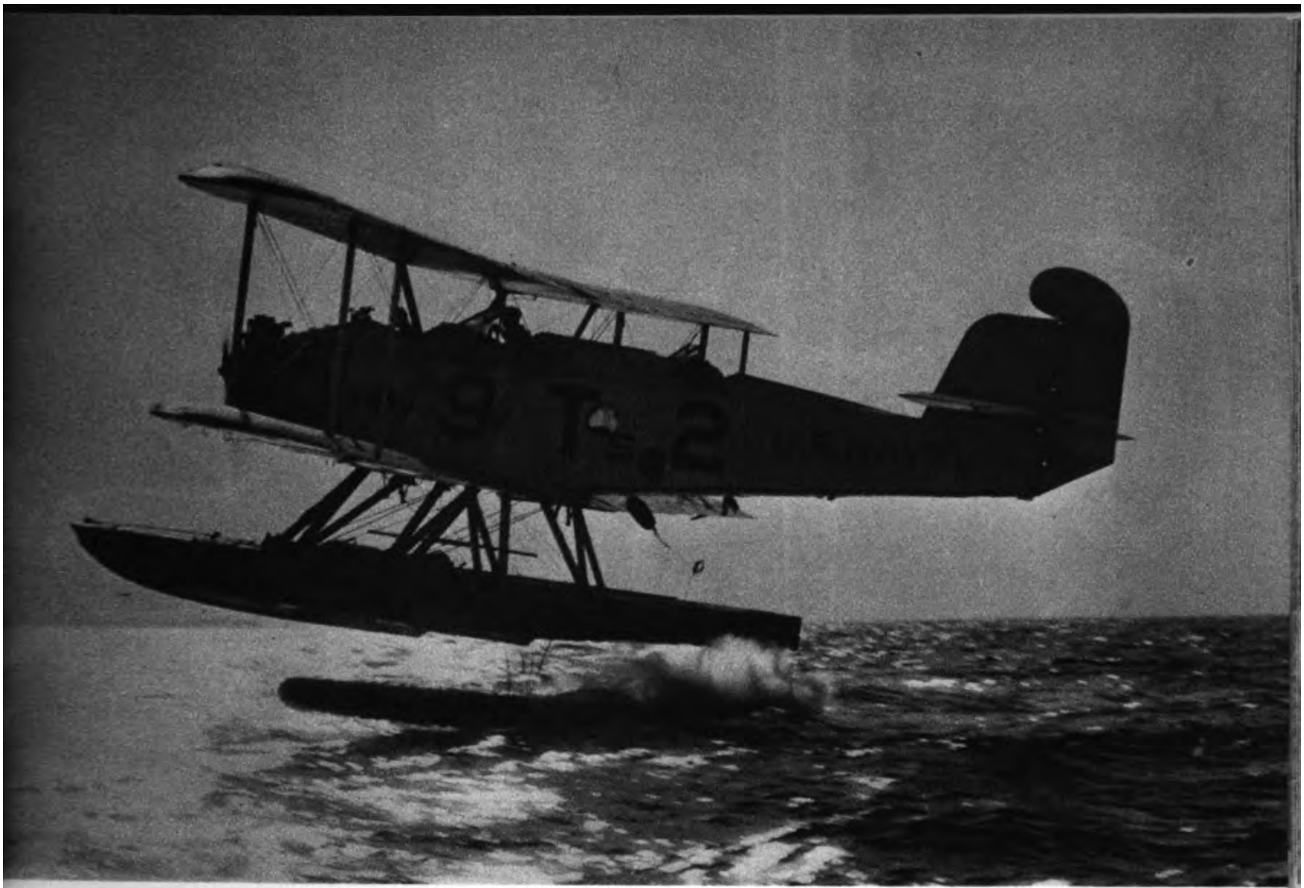
THE NAVY
SET RECORDS,
WON RACES

Lieutenant Apollo Soucek set altitude records for the Navy in 1930. Left: Lieutenant Soucek dressed for a high altitude hop. Below: The Wright Apache seaplane used by Soucek for experimental flying at high altitudes.

A pair of Navy seaplane racers typical of machines developed for participation in the Schneider International Speed Races of 1923 and 1925.

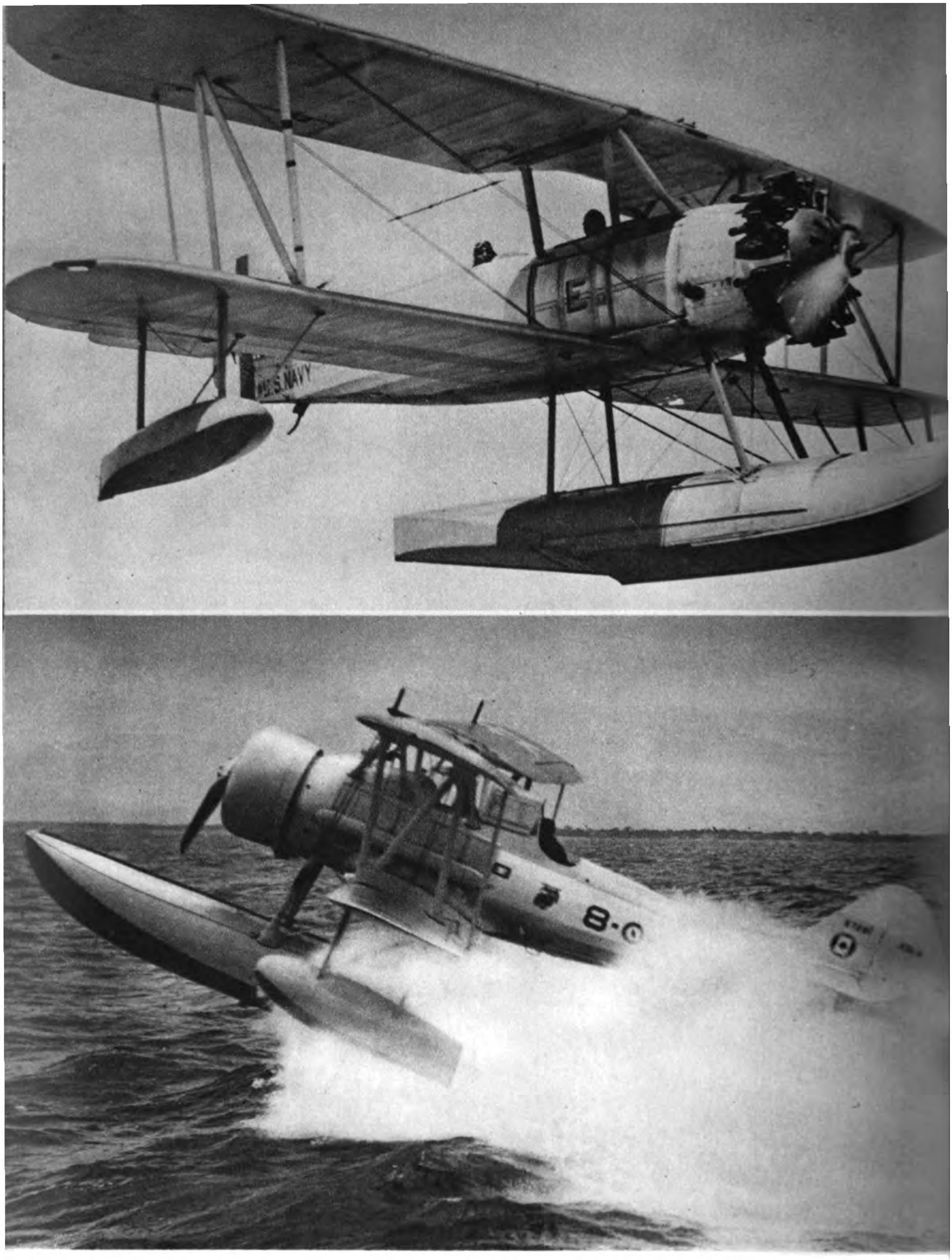


Torpedo carriers of the vintage of 1927-28—Martin T3M's with Packard engines. In the take-off picture below a torpedo may be seen slung beneath the fuselage.

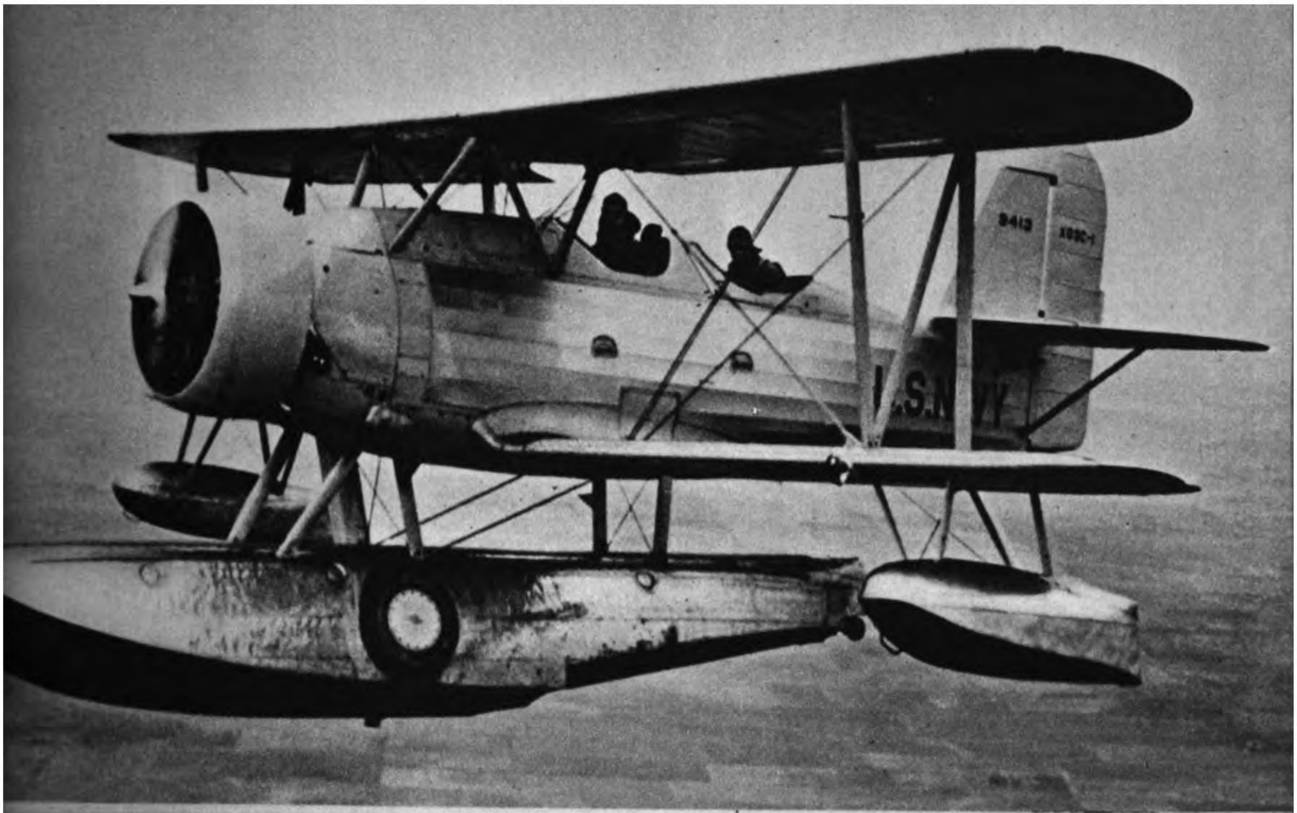


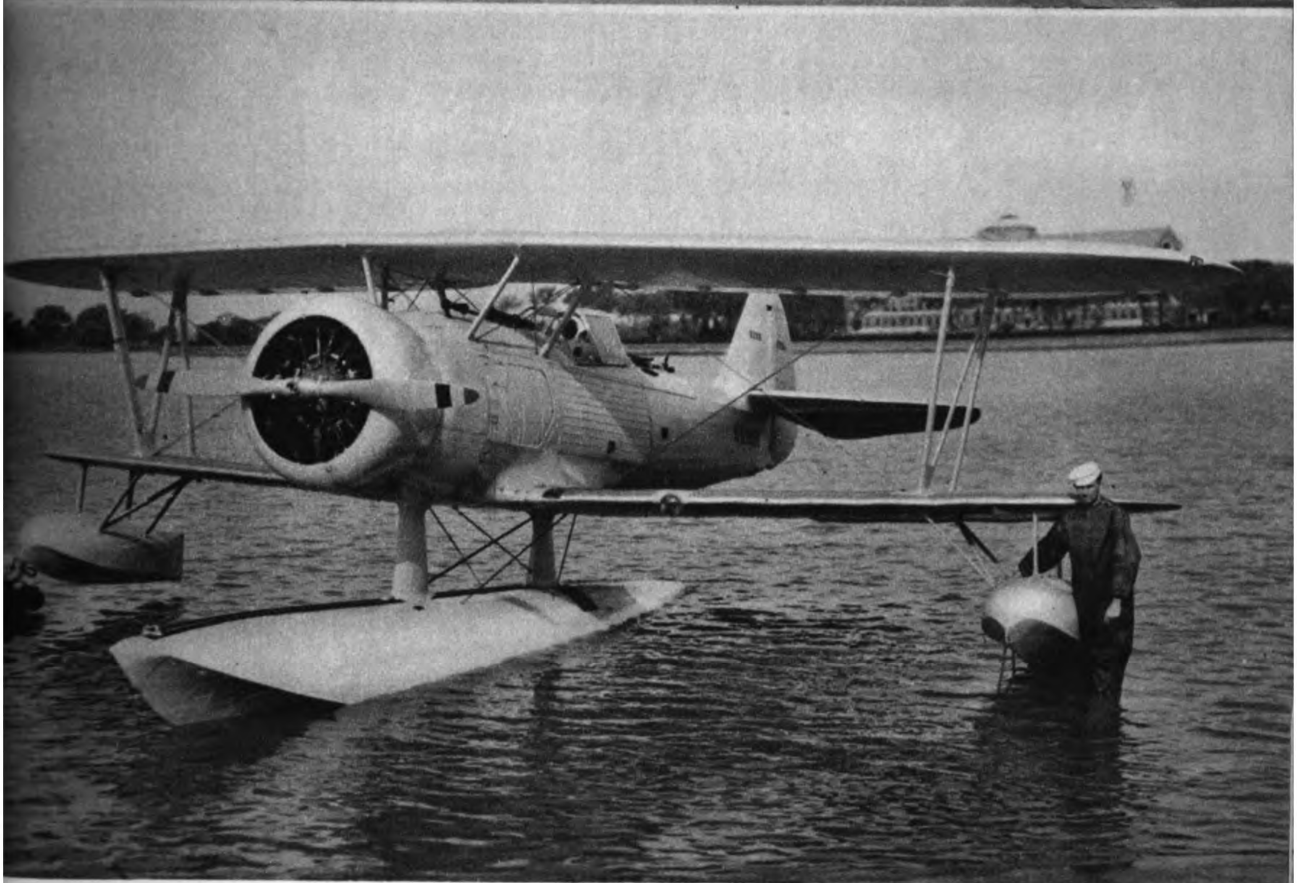
An early torpedo plane drops its load. Pictures of modern torpedo planes in action are on restricted lists, but the technique is the same.

An experimental torpedo carrier in the modern manner, the Hall XPTBH-2.



For many years the Vought Corsair was the standard Navy observation seaplane. Top: An O2U in flight. Note the uncowled engine and exposed gasoline tanks in the sides of the fuselage. Bottom: The later O3U in a rough water landing test.





Top: An experimental Curtiss observation machine of 1924 on an amphibious float gear. Bottom: One of the last of the Corsairs, the XO5U of late 1934. Compare float attachments with machines on opposite page.

Navy planes must be able to take it. An SON-4 in heavy weather.

Touchdown—a twin-float XSB2U-3 coming in for a landing.

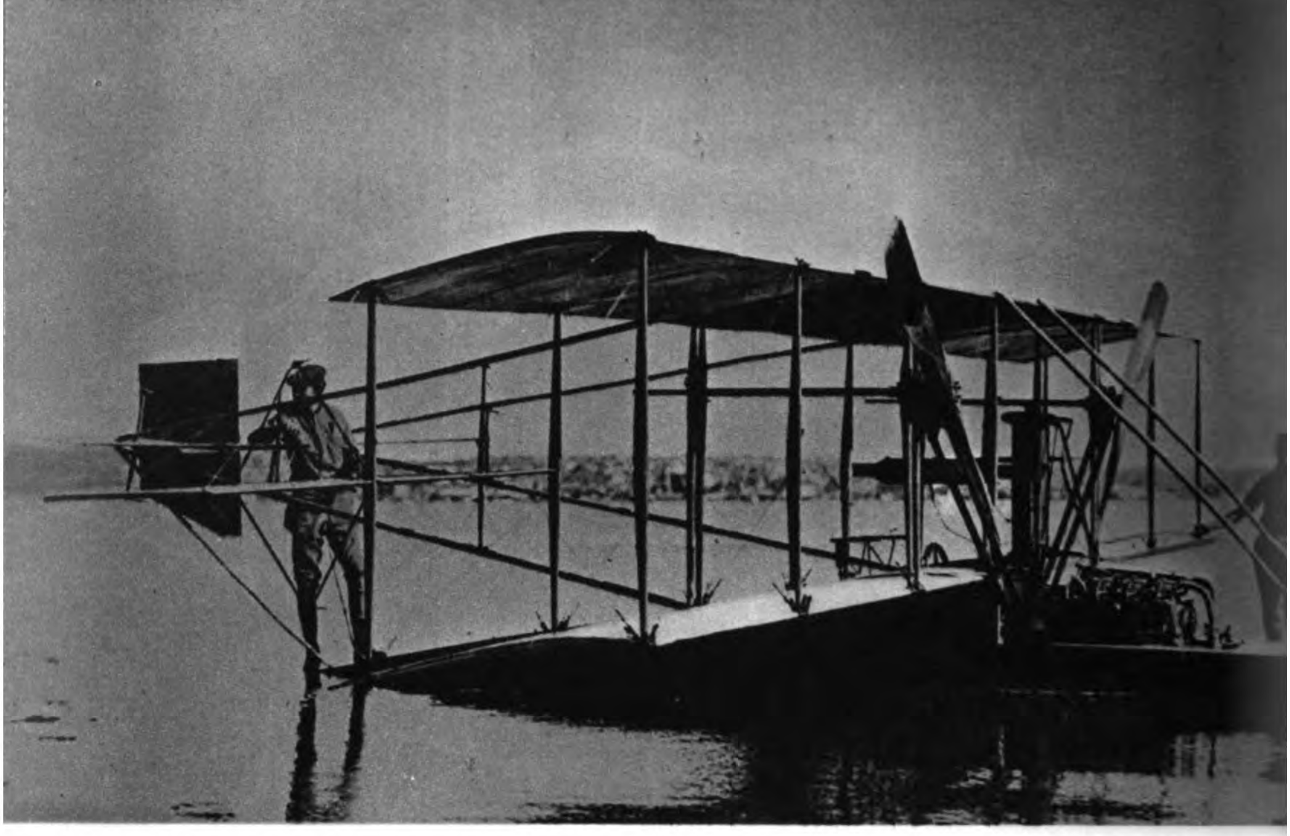
Current trends. Above: The Curtiss XSO3C-1 with an inverted 12 cylinder vee air-cooled engine. Below: The Vought OS2U-2 landing in a choppy sea.

Cruisers and battleships carry three or four scout observation planes each. This is a group of Curtiss SOC-1's.

HEAVIER THAN AIR

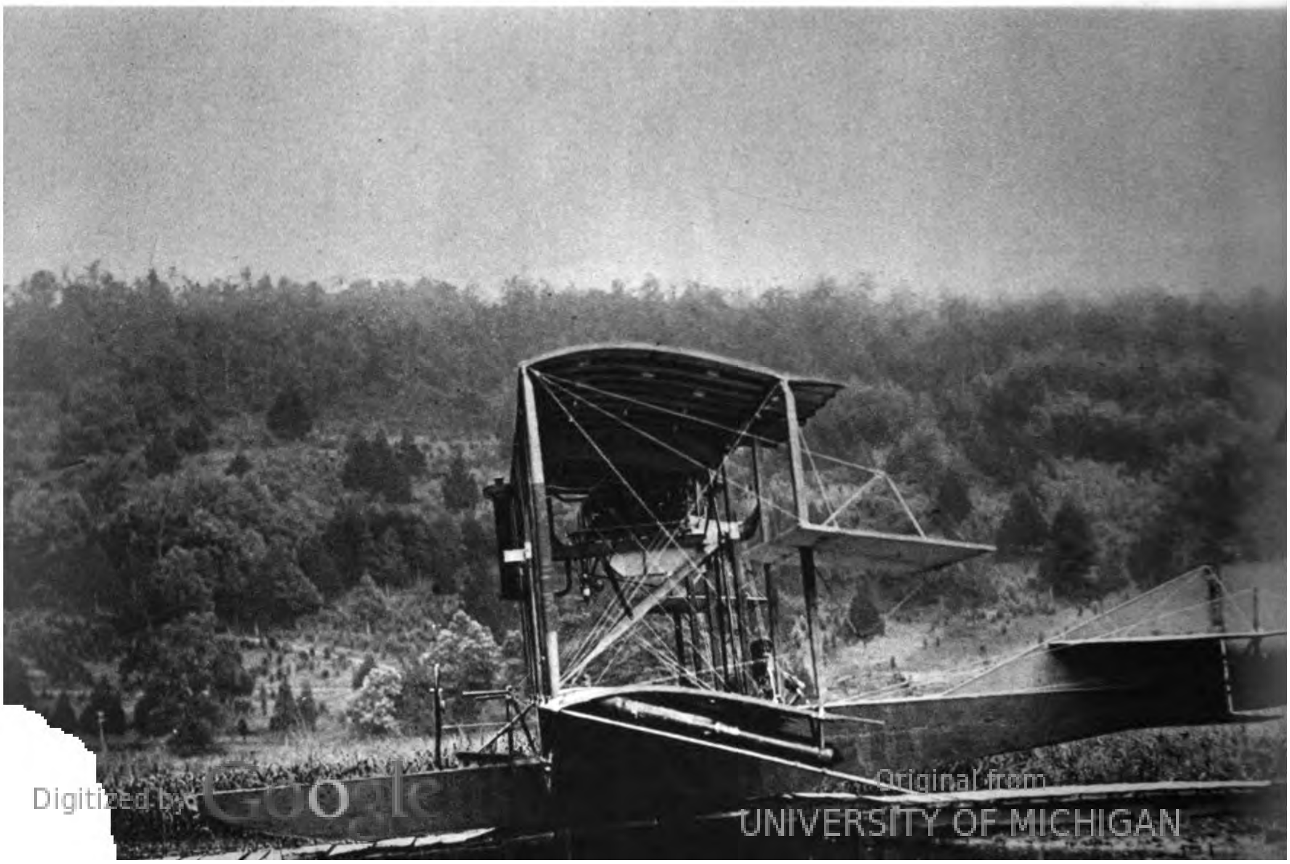
Flying Boats

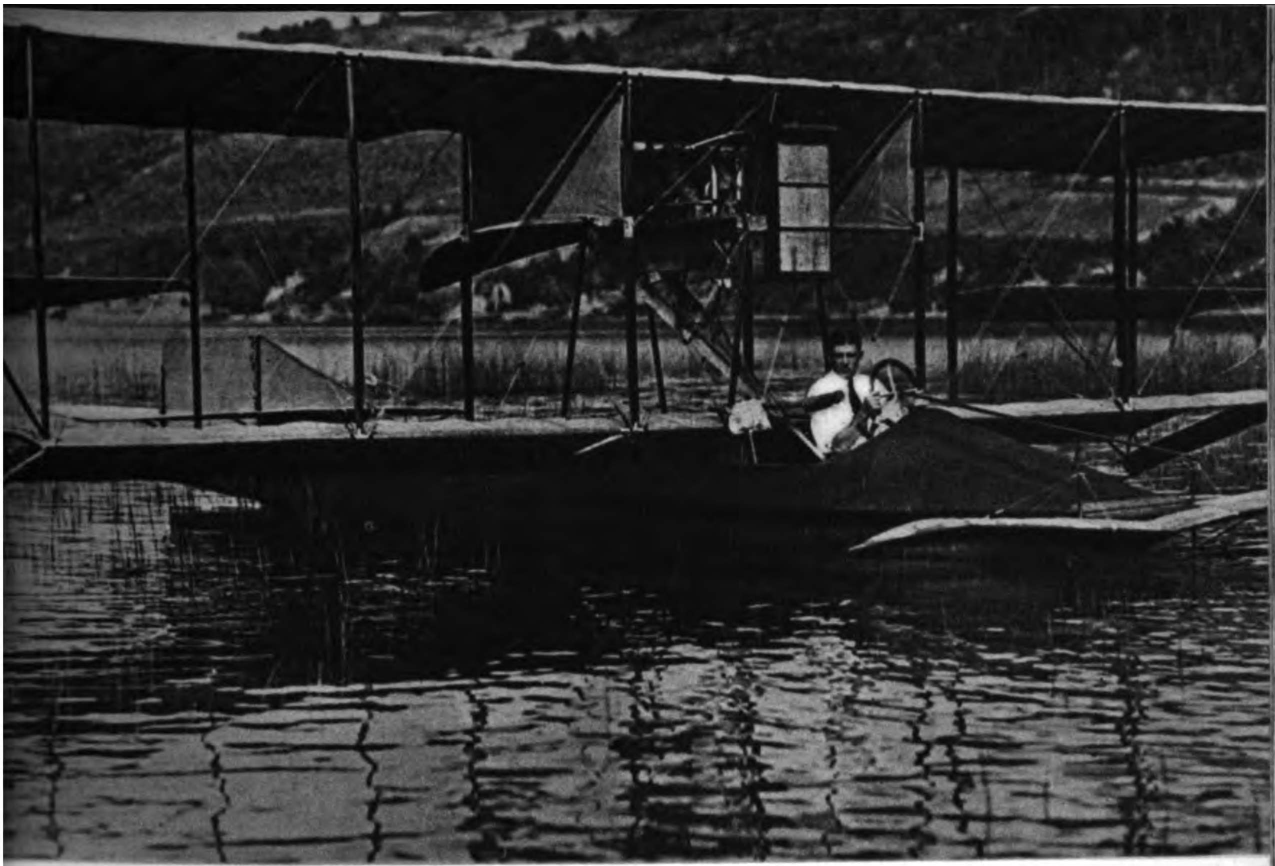
From *Flying Fish* to Flying Battleship



First flying boat attempt. A Curtiss hydro with engine and pilots in the hull. It was not a success (1911).

First successful flying boat. The *Flying Fish* on Lake Keuka in 1912. (*Courtesy Aviation Magazine*)





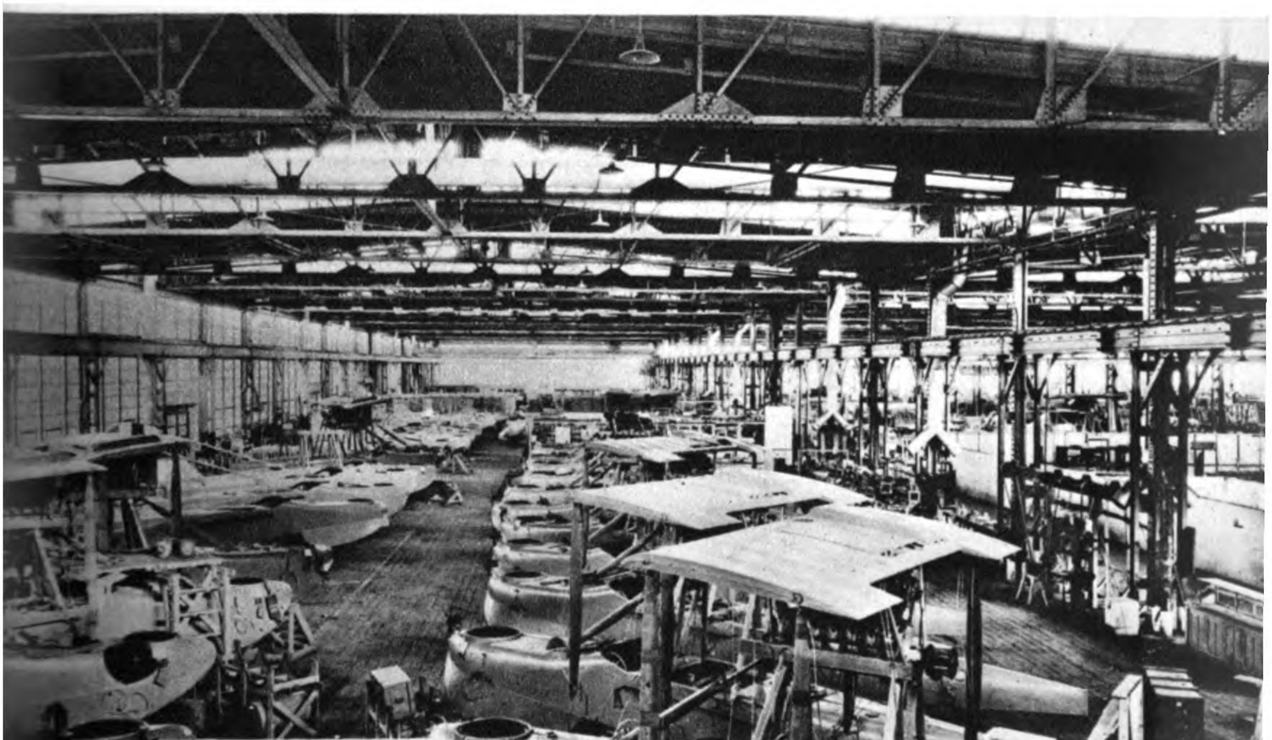
The modified *Flying Fish* could accommodate two pilots. Note elevator forward.

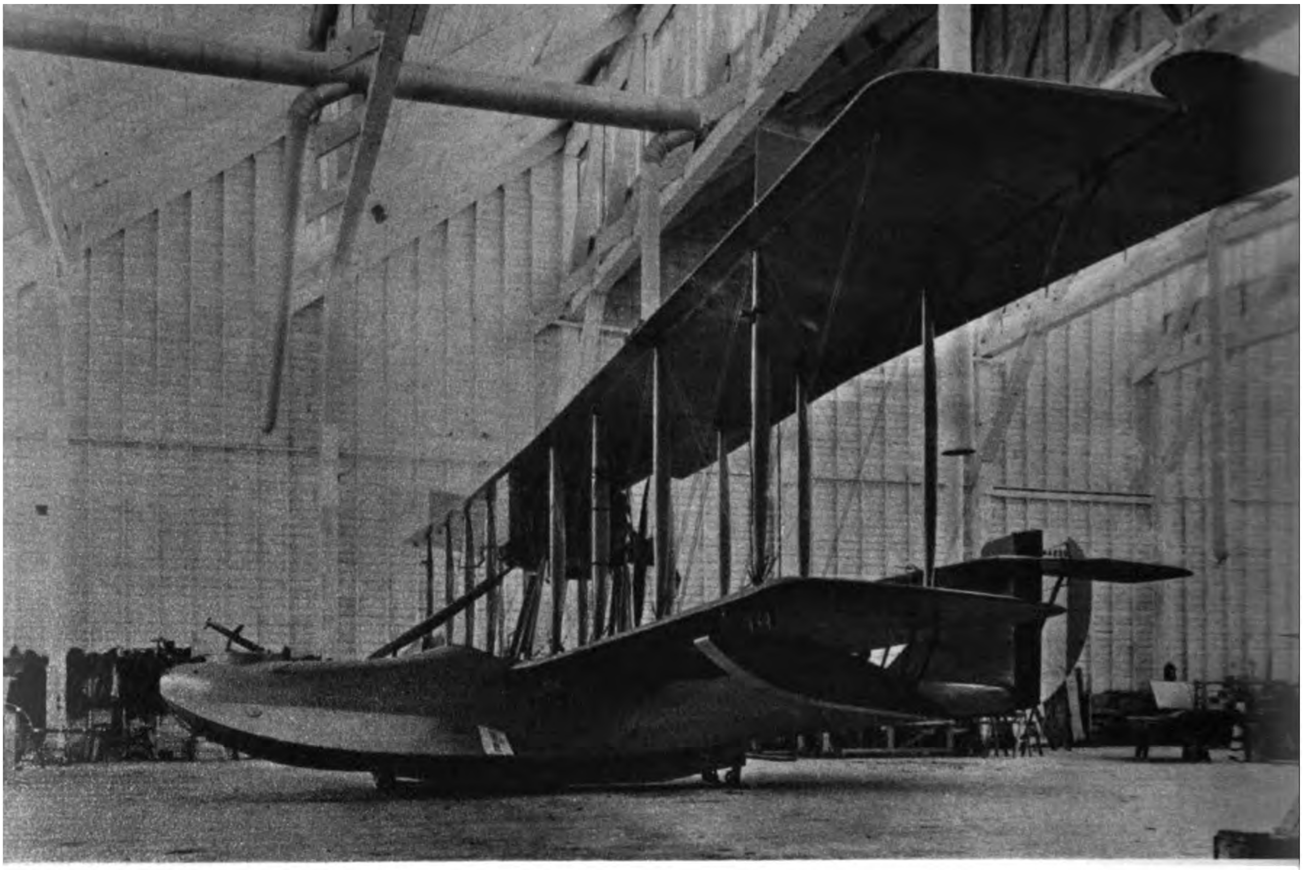
The Navy's first flying boat, a Curtiss machine of about 1912.

Two early Curtiss flying boats. Above: The U.S. Navy's C-2. Left: An F boat of 1913 with improved OX-5 engine. (*Courtesy Curtiss-Wright*)

By 1915 inter-plane ailerons (see above) had been replaced by the now common trailing-edge types. (*Courtesy Curtiss-Wright*)

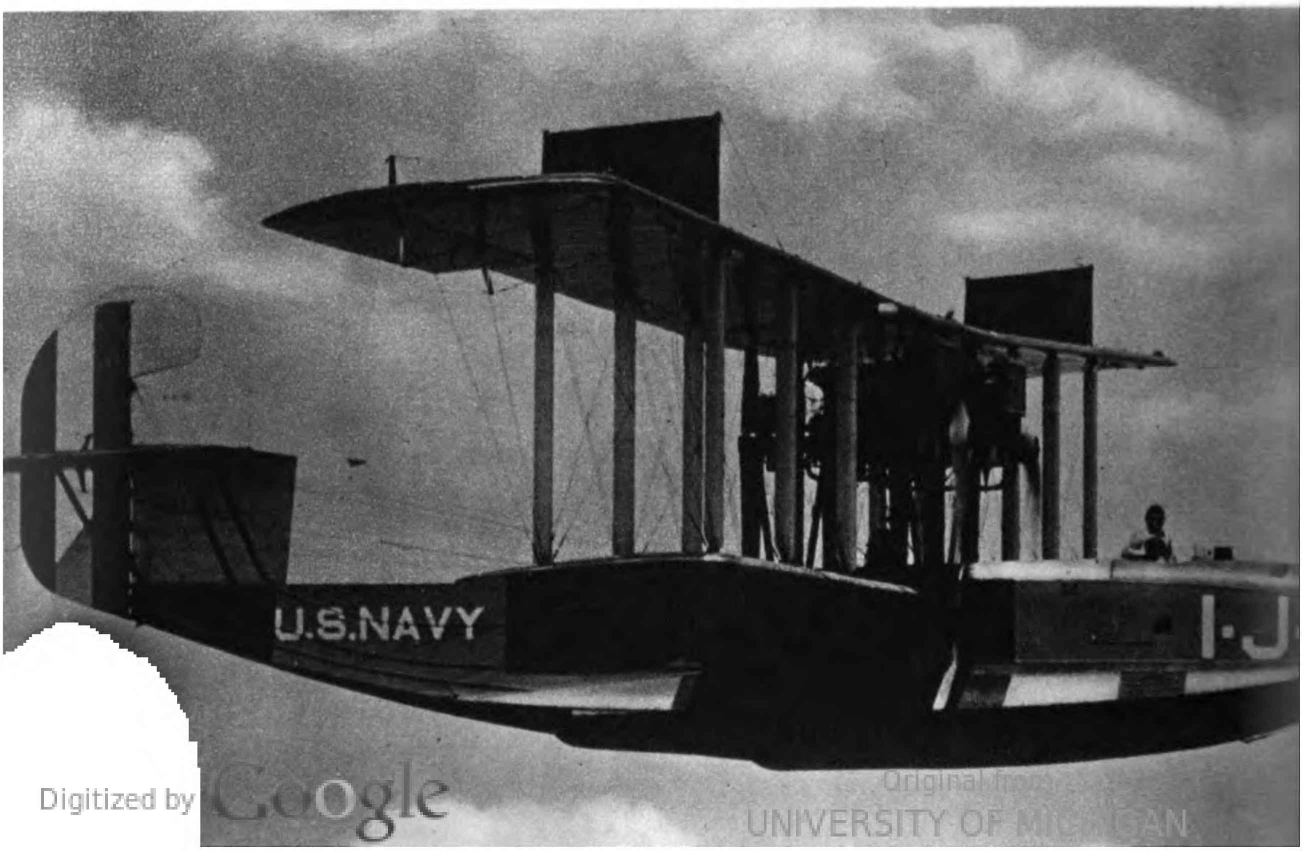
The Curtiss F5L and HS-1 were mainstays of our Flying Fleets during the latter stages of the war of 1917-18. Above: An HS-1 landing. Below: The Curtiss Aeroplane and Motor Company's HS-1 production line as it appeared on Armistice Day of 1918. (*Courtesy Curtiss-Wright*)

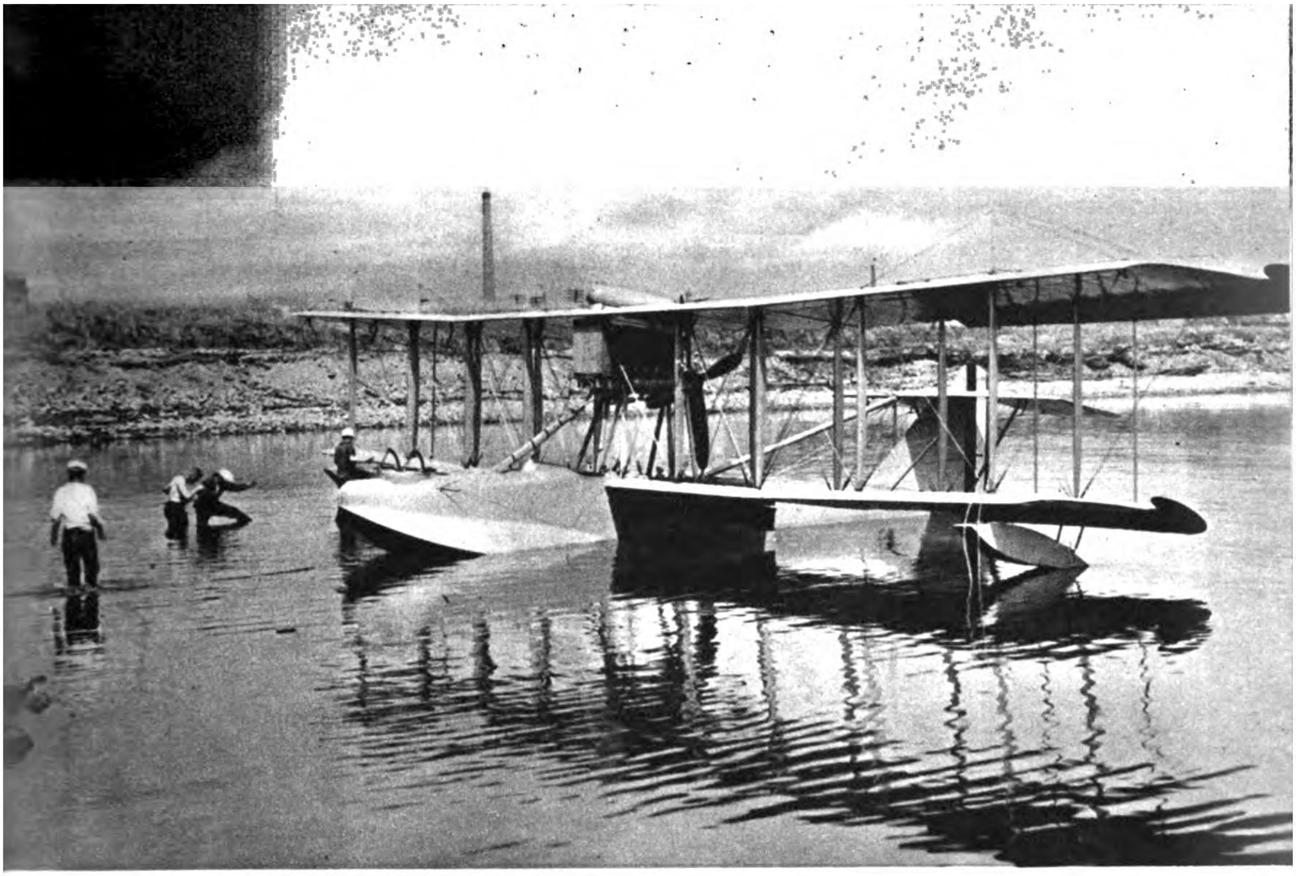




Boeing built a number of these three-place HS-2L gunnery training planes in 1918. (*Courtesy Boeing Airplane Company*)

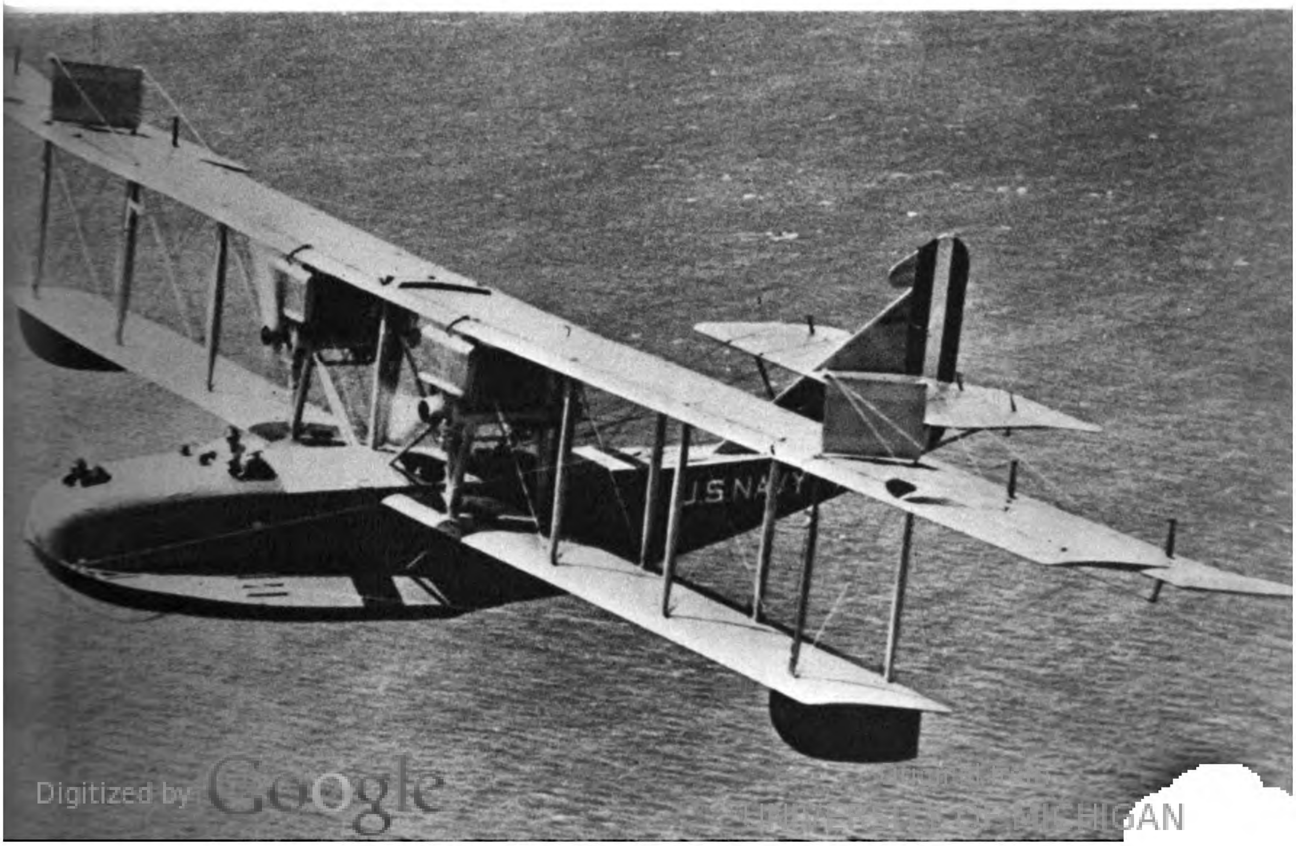
The twin-motored F5L was familiar to post-war Navy pilots.

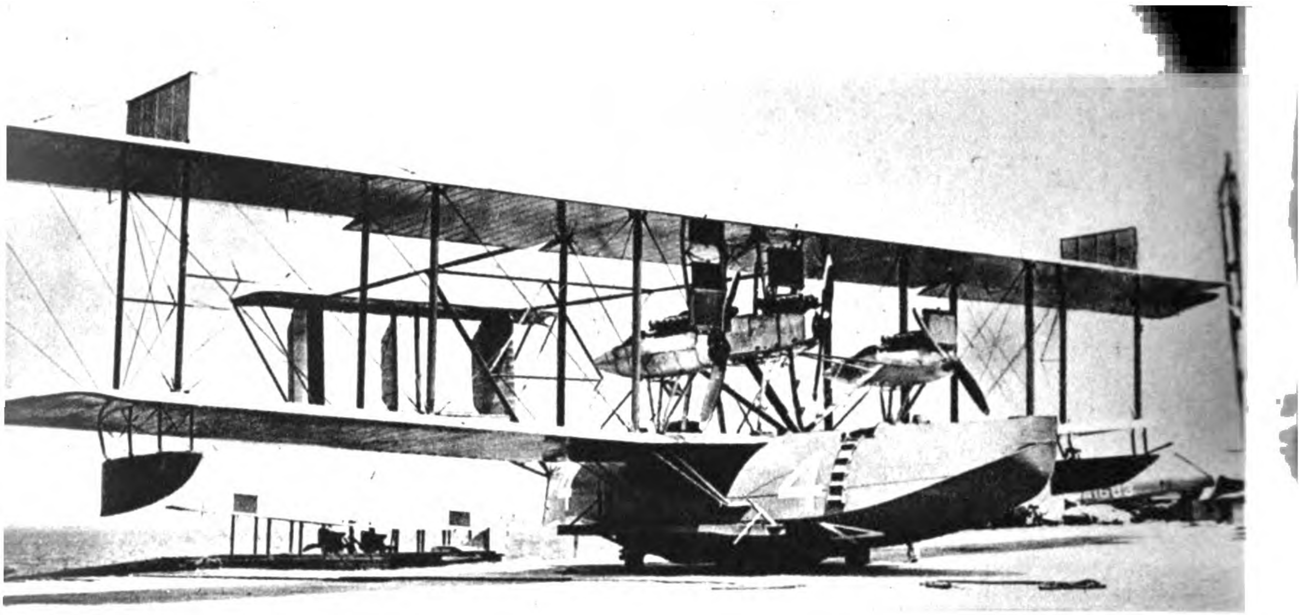




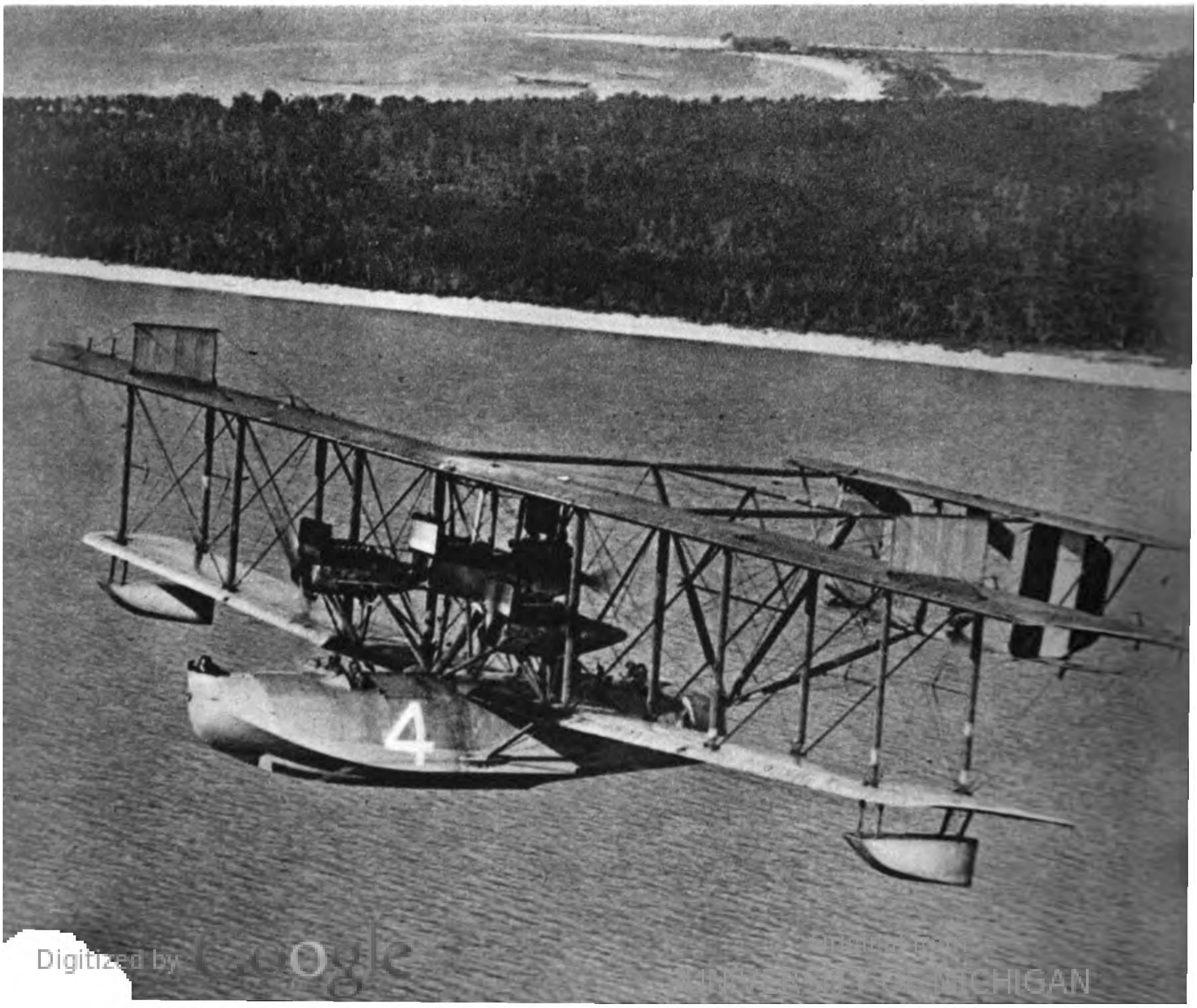
A Curtiss HS2L of 1918. (*Courtesy Curtiss-Wright*)

Another war-time type—the H-16.



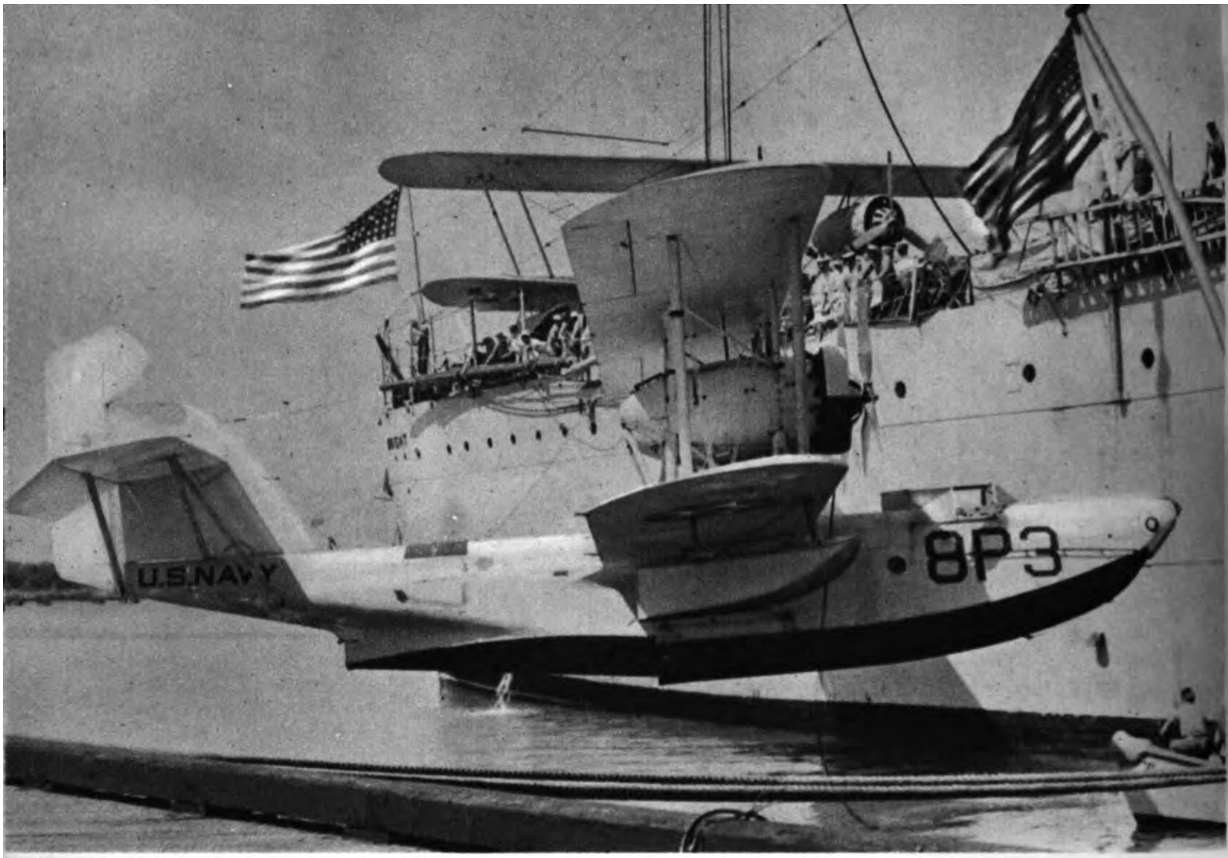


First across the Atlantic—the Curtiss-built NC-4 flying boat which arrived in Lisbon May 27, 1919. The hull is now on display at the Smithsonian Institution, Washington, D. C. (*Courtesy Curtiss-Wright*)



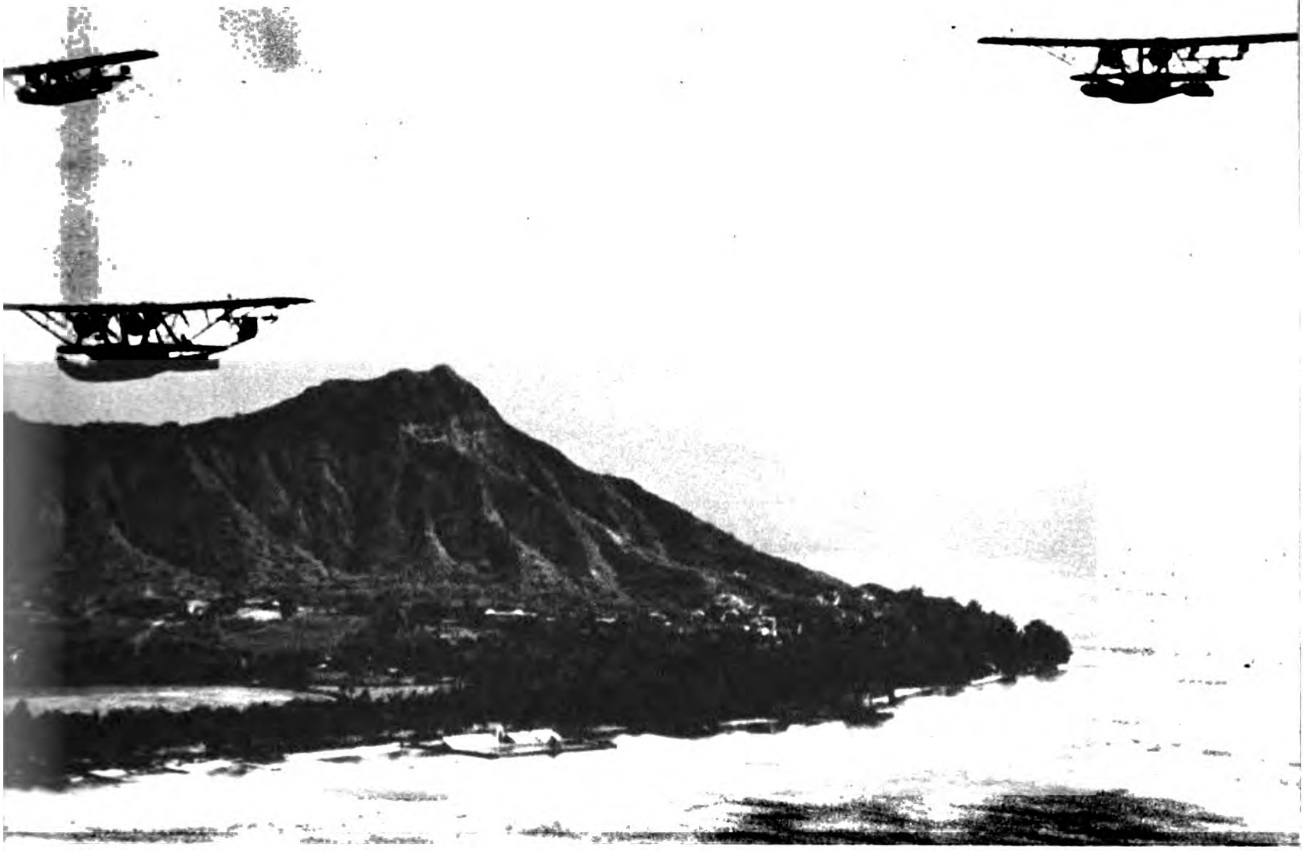
A group of Martin patrol bombers lay some eggs. This type is long since obsolete.

In 1925 Boeing built the 13-ton PB-1, largest airplane of its time. (*Courtesy Boeing Airplane Company*)



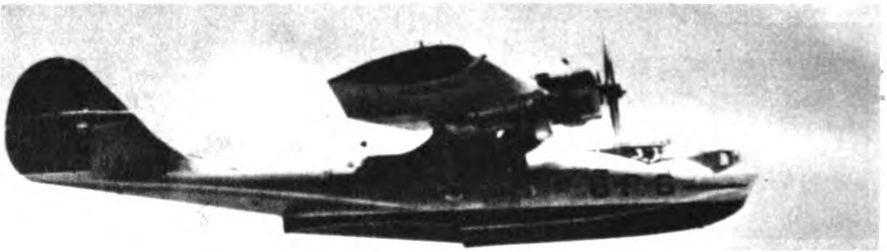
The tender *U.S.S. Wright* puts a PH-1 over the side at Honolulu (1934). This was before the days of transoceanic delivery by air.

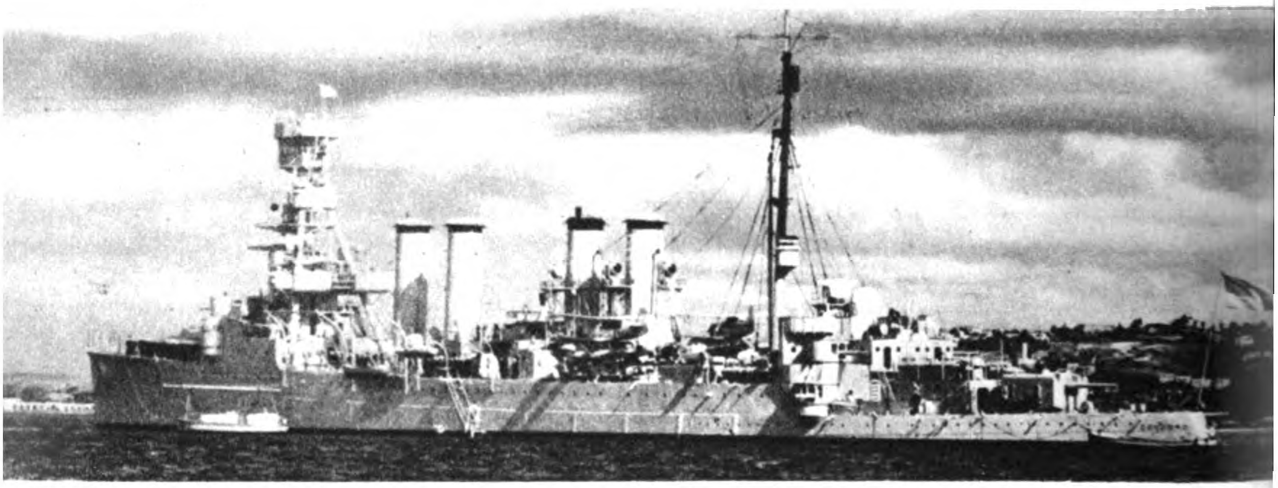
By 1937 the Navy had patrol boats capable of crossing the Pacific. This is a P2Y2.



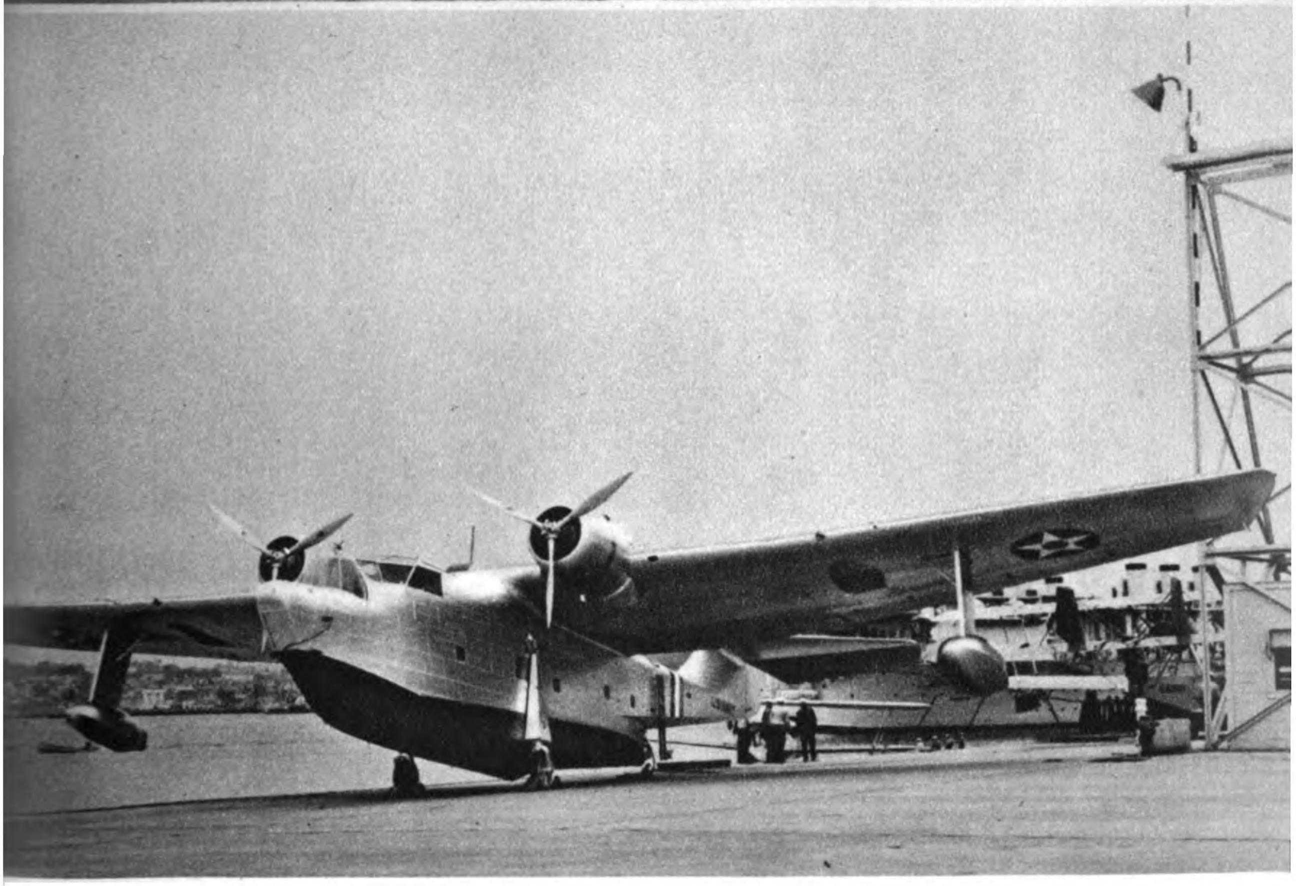
End of the first non-stop formation flight—San Diego to Pearl Harbor, Hawaii, January 1938.

"Routine Transfer." A group of Consolidated PBY's above the clouds en route to Hawaii.





On service with our Flying Fleets. Top: Newest of the PBY's, the Model 4. Note streamlined gun blister amidships. Bottom: A patrol bomber salutes the *U.S.S. Concord*.



Top: The addition of retractable tricycle-type landing wheels makes an amphibian of a patrol bomber—the XPBY-5A.

Bottom: A Douglas-built patrol bomber, the P3D-1.

Above: Flying battleship—the Consolidated PB2Y-2, in production in 1941. Below: The prototype, XPB2Y-1. Note how the production model above has been cleaned up around the nose and the nacelles.

Another flying battleship, the Vought-Sikorsky XPBS-1. In the lower picture she is seen taking off from San Diego for Pearl Harbor on April 5, 1940.

A PBY-3 comes alongside a tender for a long drink.

comes

HEAVIER THAN AIR

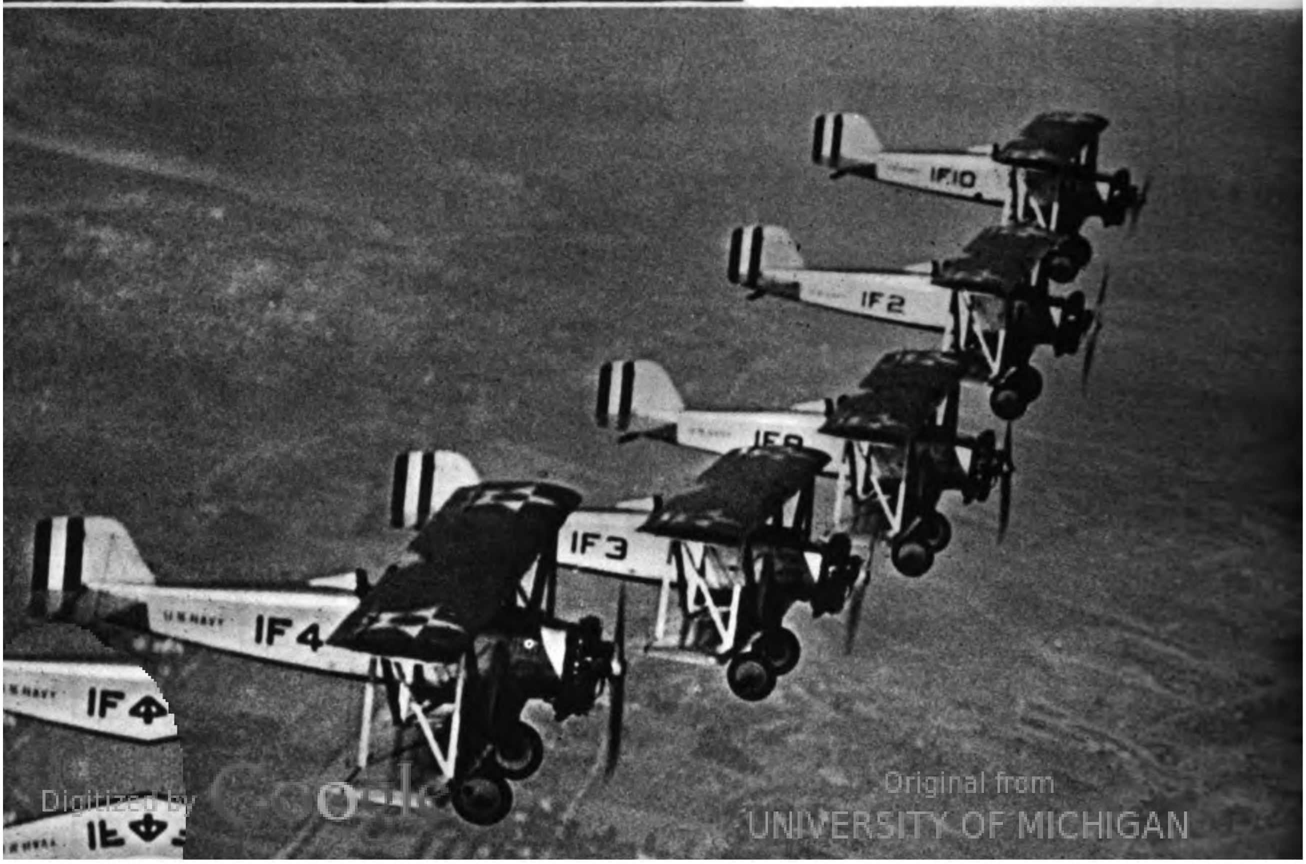
Landplanes

Fighters, Bombers and Scouts

Aerobatics. A Boeing Navy fighter of 1927.

PROTOTYPE
FIGHTERS

A group of early air-cooled fighters, a squadron of TS-1's. (*Courtesy Aviation Magazine*)



Aerobatics. A Navy fighter, the Curtiss XF7C at the top of a loop over Washington's tidal basin.

STUNTS AND
RACES

The Navy Curtiss racer built for the Pulitzer Race of 1923. This machine is now in the Smithsonian Institution, Washington, D. C. Note wing skin radiators.

An early carrier fighter the Boeing FB-5 o 1927. (*Courtesy Boe ing Airplane Company*)

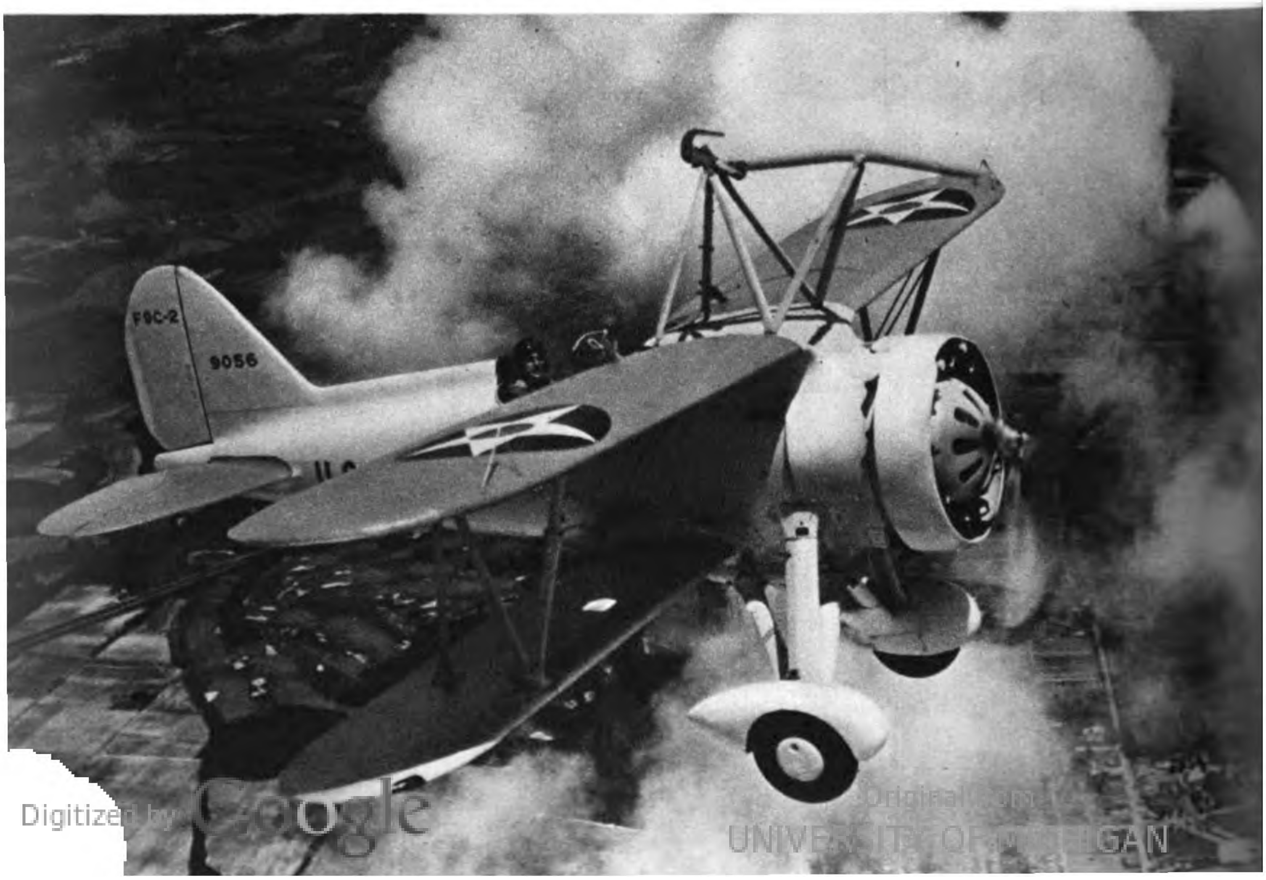
An experimental deck fighter of 1928, the Curtiss XF7C-1. (*Courtesy Curtiss-Wright*)

Compare this Boeing F4B-1 of 1929 with the FB-5 at the top o the page. (*Courtes Boeing Airplane Com pany*)

Aerobatic formation. A "stack" of Navy fighters of 1929. By the late 1920's the radial air-cooled engine was standard equipment in naval aircraft.

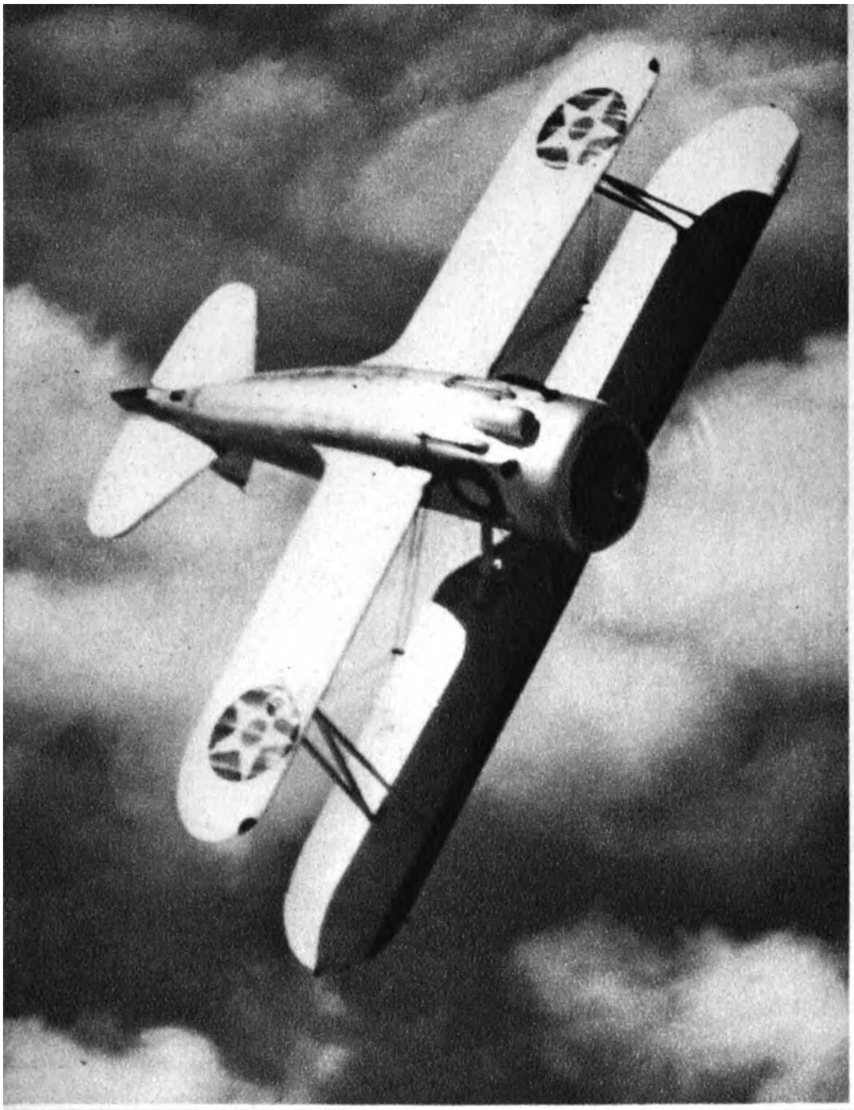
In 1932 the Boeing F4B-3 fighter was found on board all U.S. aircraft carriers. (*Courtesy Boeing Airplane Company*)

The curious arrangement on top of this Curtiss F9C-2 was to hook on to the trapeze of the *U.S.S. Macon*. (See pages 75 and 78.)



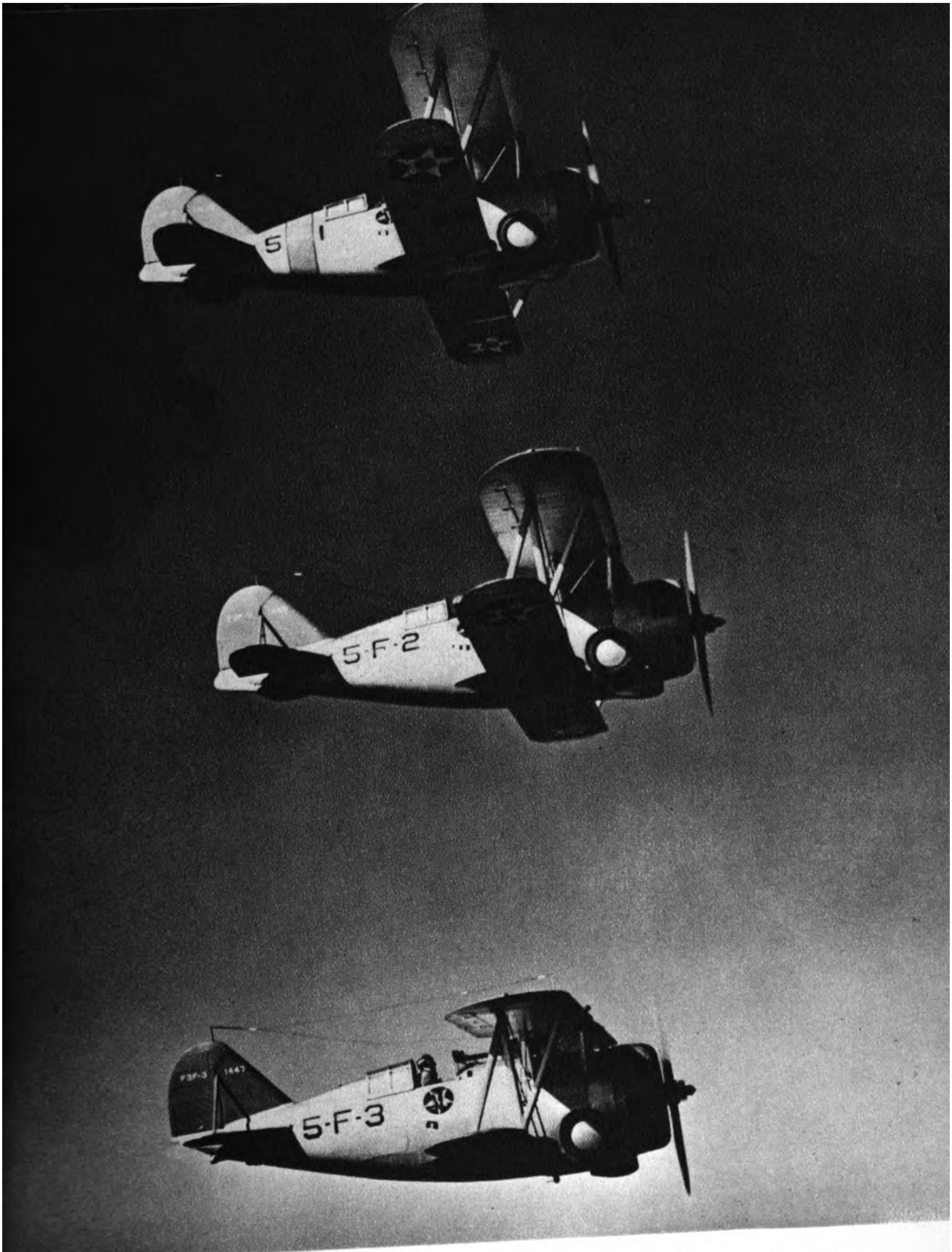
Aerobatics. A team of F2B fighters puts on a "Siamese triplet" act.

Among the last of the Navy fighters with fixed landing gears, the Curtiss XF11C-2. The "egg" between the wheels is an auxiliary fuel tank which can be dropped when empty.



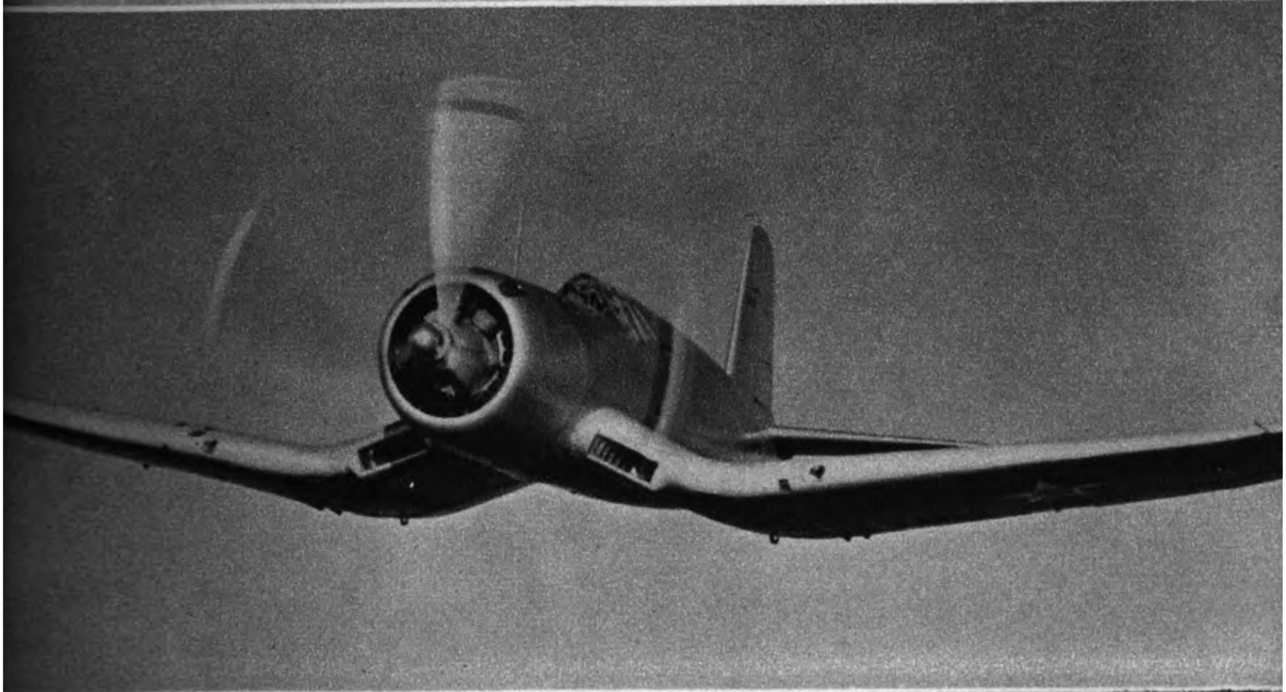
Aerobatics. A Grumman F3F belly-up at the top of a roll.

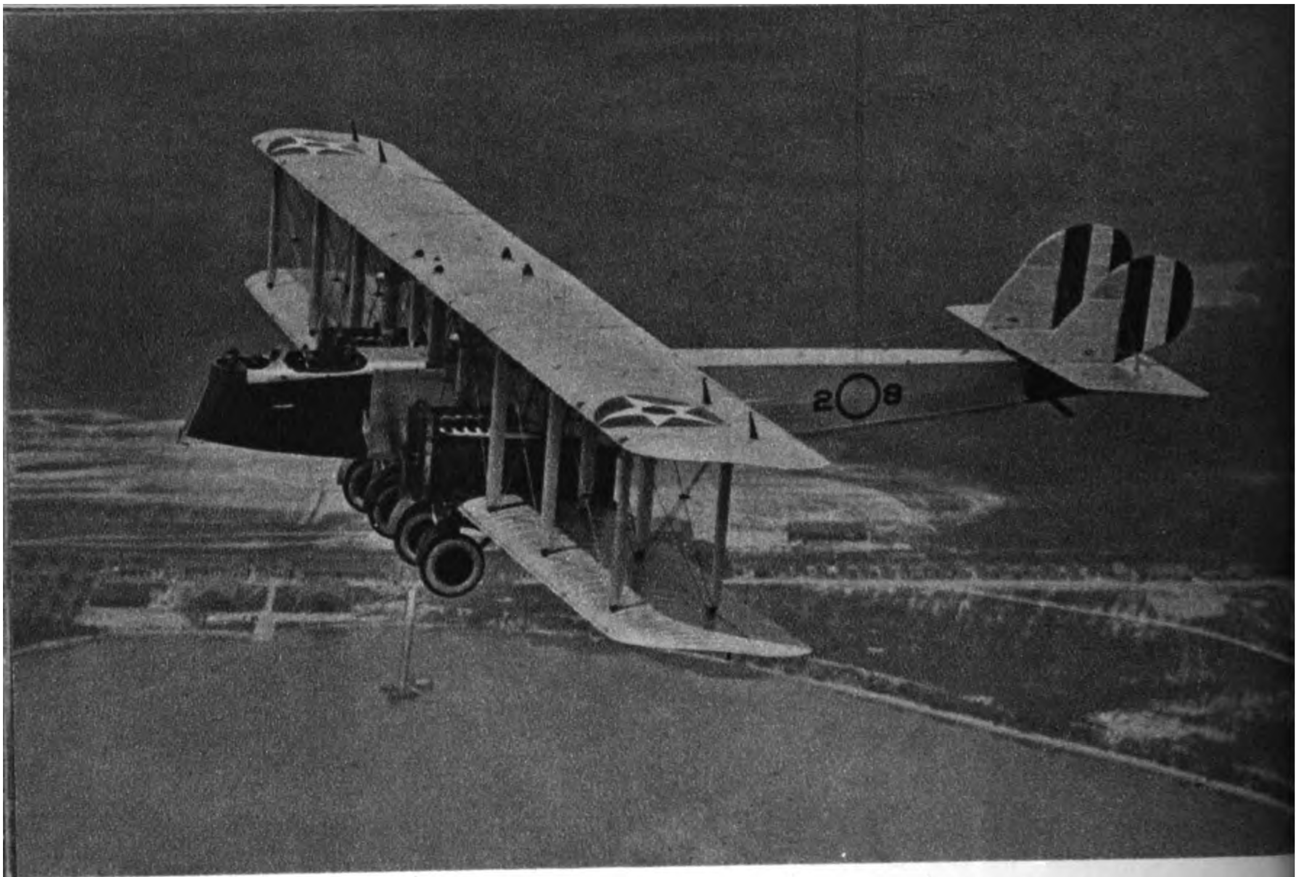
By the end of 1935 retractable landing gear had become a requirement for all Navy fighters.



Aerobatics. A stack of Grumman F3F-3's. These ships are now found on board most U.S. carriers.

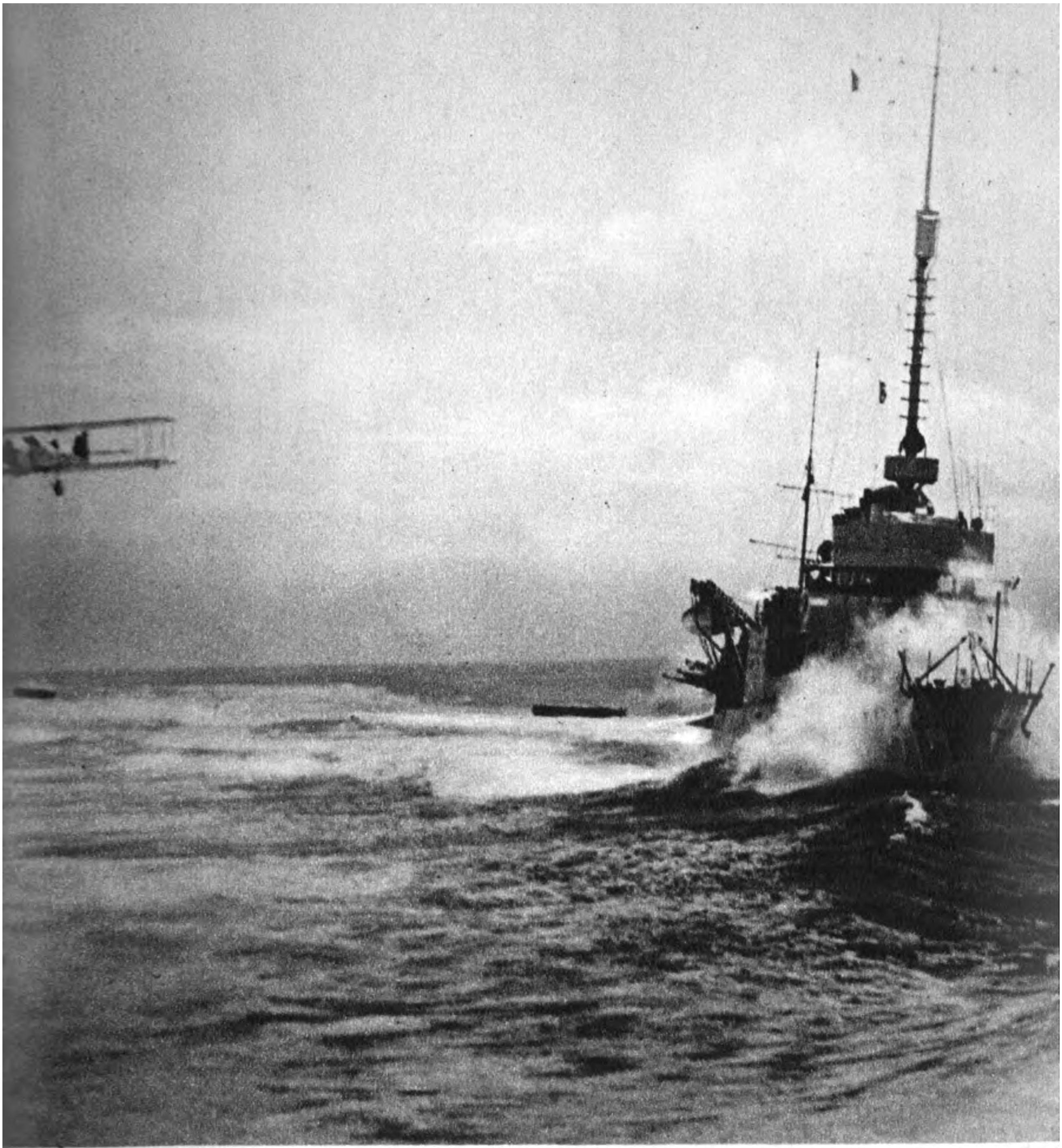
In the modern manner—a group of the latest deck fighters of the Flying Fleets. Above: A Grumman XF4F-3. Right (top to bottom): The Brewster XF2A-1; The Vought-Sikorsky XF4U-1, among our fastest service airplanes; The Grumman "Skyrocket," an experimental twin-engined type.





First of the Navy torpedo bombers was the twin-engined Martin of 1919-20.

By 1925 Martin was building SC-2 scout torpedo bombers. The split under-carriage permitted mounting a torpedo along the under-side of the fuselage. (*Courtesy Glenn L. Martin Company*)



Torpedoes from sea and air. A Martin T4M "fires" simultaneously with the *U.S.S. Zeilan.*

The Great Lakes bomber of about 1935.

First of the Navy's dive bombers. A Martin BM-1 of 1931. A 1,000-pound bomb is slung between the wheels. (*Courtesy Glenn L. Martin Company*)

The Northrop-designed XBT-1. The perforated flaps may be used as diving brakes.

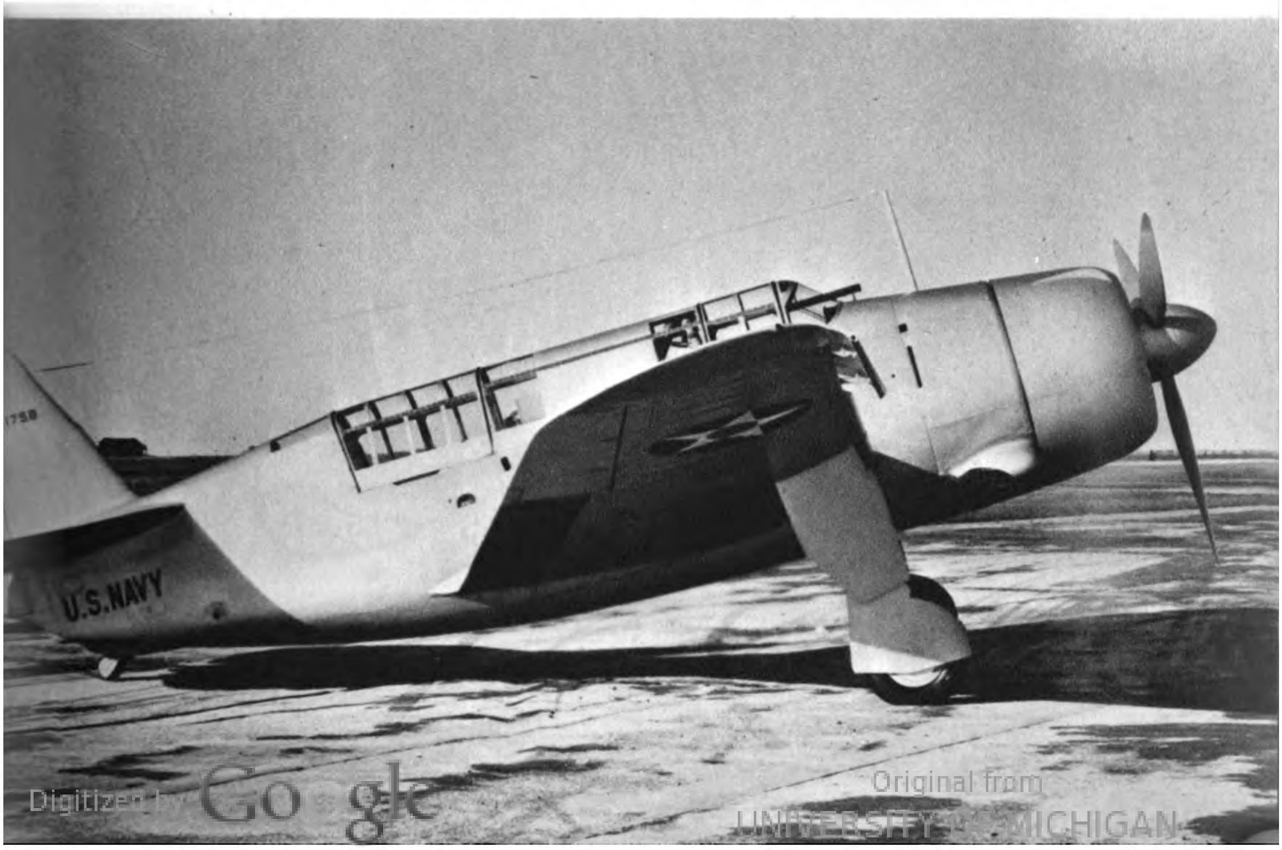
A line-up of Curtiss SBC-4 scout bombers (1939).

Scout bombers of 1941. Above: The Douglas SBD-1.

Below: The Douglas TBD-1.

Scout bombers of 1941. Above: The Vought-Sikorsky SB2U-2.

Below: The latest experimental type—Curtiss XSB2C-1, first flown December 1940.




U.S.NAVY

Opposite top: The Curtiss Falcon OC-1 was the standard observation type of 1928. (*Courtesy Curtiss-Wright Company*)

Opposite center: Hell-diver. The Curtiss O2C-1 of 1931. (*Courtesy Curtiss-Wright*)

Opposite bottom: Land plane version of the Vought Corsair of 1933.

Right: Formation of carrier-based Corsairs.

Below: Observation planes laying a smoke screen around the Fleet.

Built by the Naval Aircraft Factory, the XOSN-1 (1938).

First take-off from the deck of the *U.S.S. Wasp*—Commander J. J. Cassidy in an SOC-1.

Cruiser-based SOC-1's. Ordinarily they are fitted with floats for catapult launching.

A section of OS2U-1's over Anacostia (November 1940).

Land plane versions of two current scouting types. Above: The XOS2U-1. Below: The XSO3C-1.

Down at sea. How emergency flotation gear keeps planes afloat until they can be picked up. The deflated bags are normally stowed in streamlined containers fitted alongside of the fuselage.

HEAVIER THAN AIR

Utilities

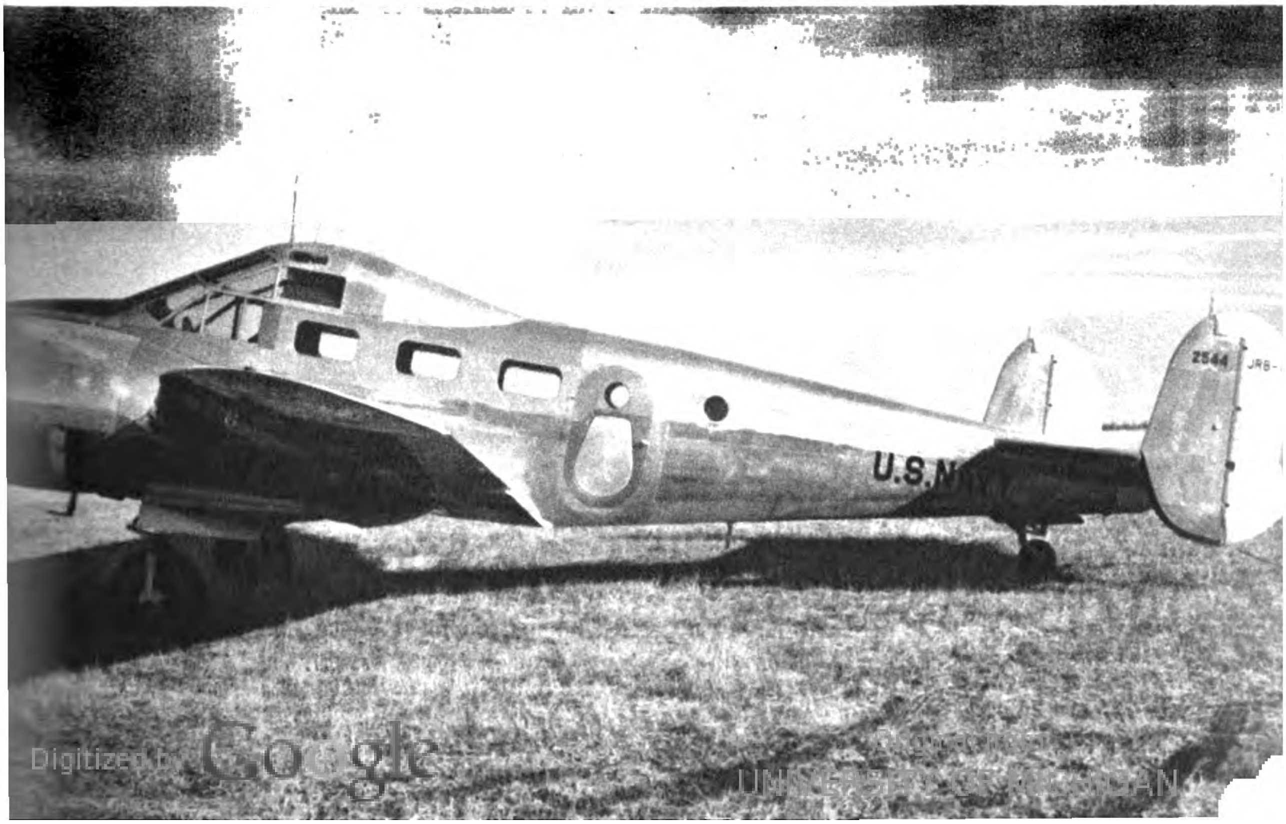
The work-horses of the Flying Fleets


U.S.NAVY

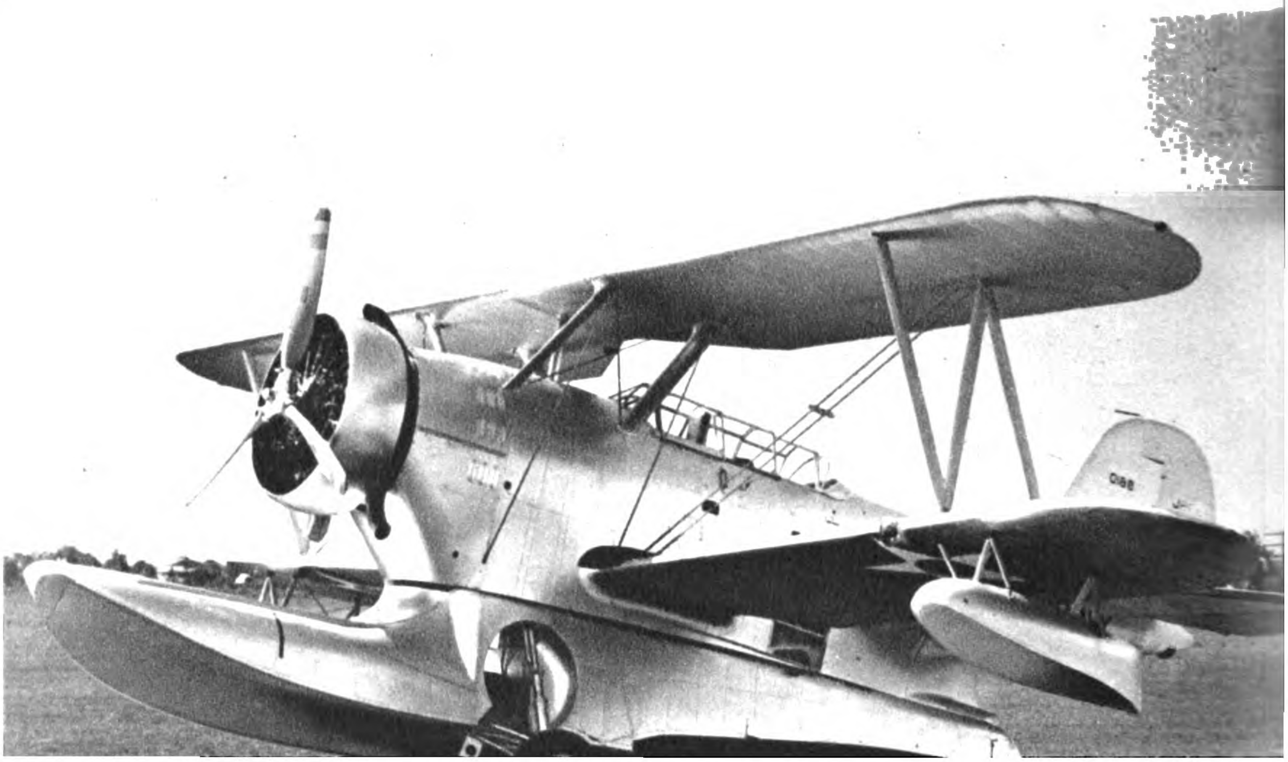

2
MARINES


VMJ-2
U.S.MARINES

For carrying personnel and cargo, the Navy uses transport aircraft of all types. (Opposite page, from top to bottom) The Ford tri-motor was widely used in 1930-32. By 1935 the Curtiss R4C-1's (Condor) had replaced the Fords. Current Navy transports include a number of Douglas R3D-2's (DC-5's) as well as several R2D-1's (DC-2's). Lockheed Loadstars (R-50-2) are now in Navy transport service. A number of smaller transport types are also on duty including the Bellanca JE-1 (above), and the JRB-1 twin-engined Beechcraft shown below.



The Loening OL-7 amphibian of 1927 (above) has a counterpart in the current Grumman J2F-1 utility (below). (*Courtesy Grumman Aircraft Engineering Corps*)

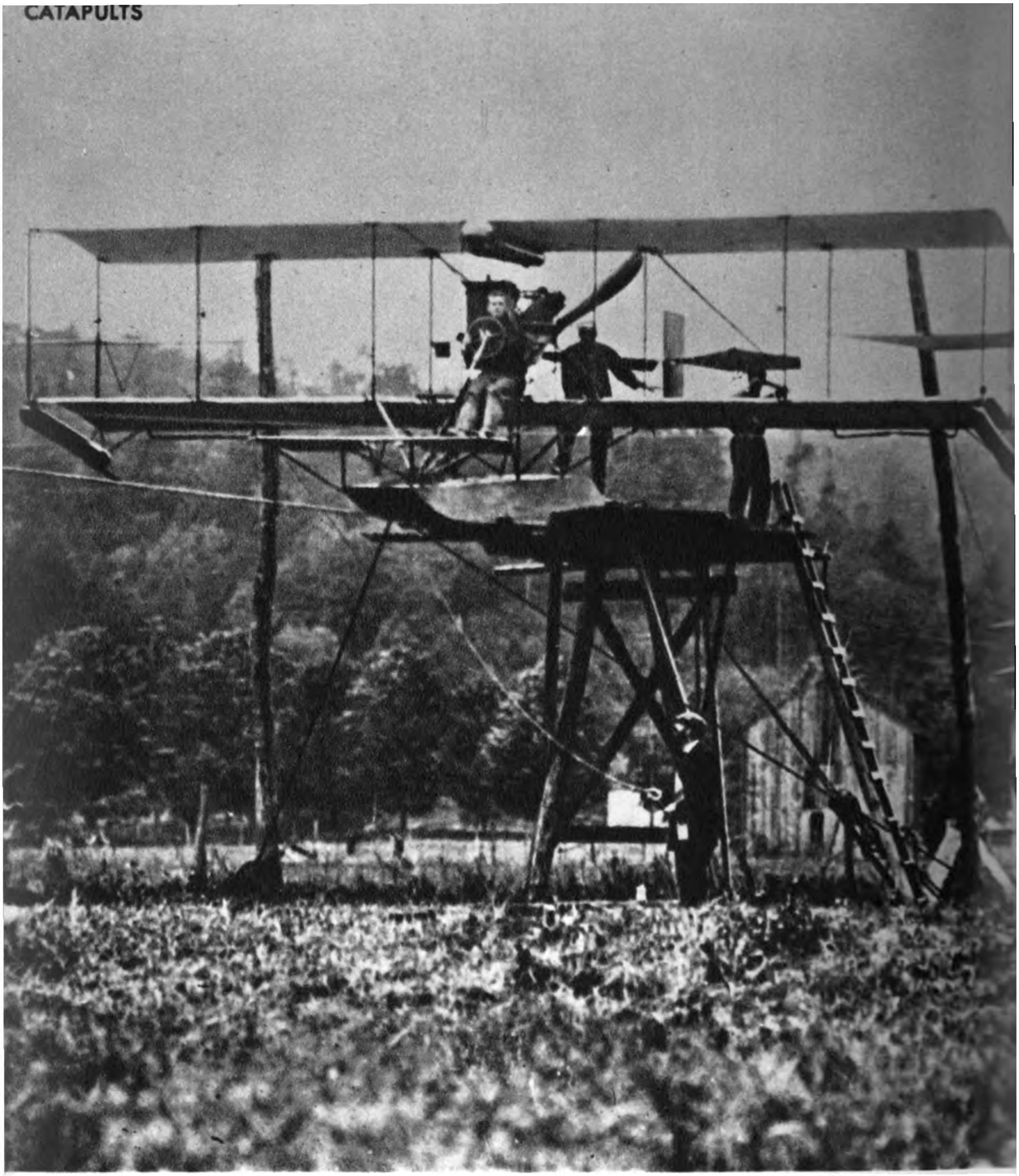


Largest of the Navy's utility transports, a group of JRS-1's. These are adaptations of the Sikorsky S-43 transports used by Pan American Airways and other commercial operators all over the world. They are the largest amphibians built.

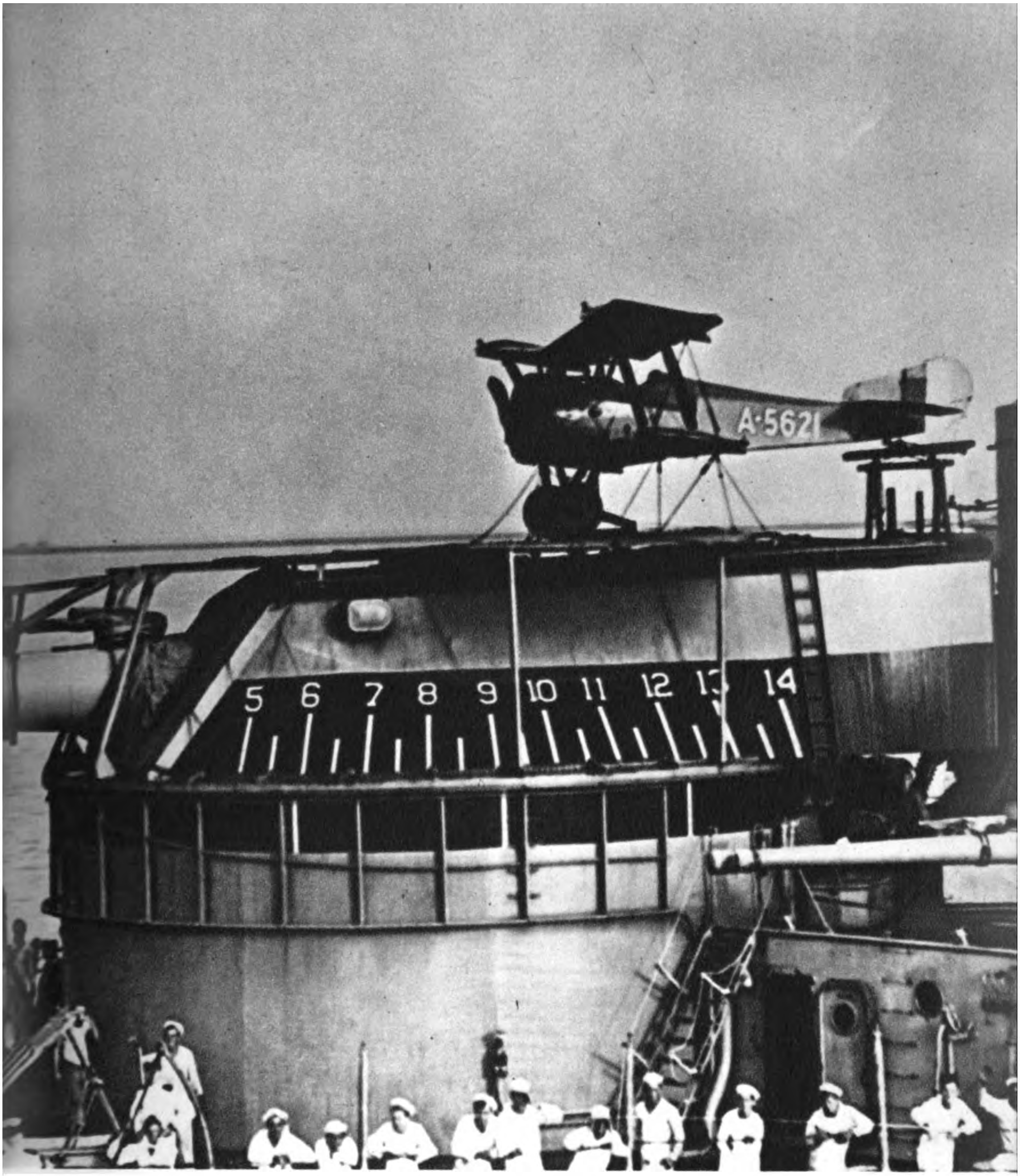
The Navy has occasionally experimented with unconventional types, including autogiros and even gliders. This is the Pitcairn XOP-2 autogiro delivered to the Navy in 1936. They have been tested on board aircraft carriers and have recently been considered as possible convoy aircraft. (*Courtesy Pitcairn Autogiro Company*)

CATAPULTS

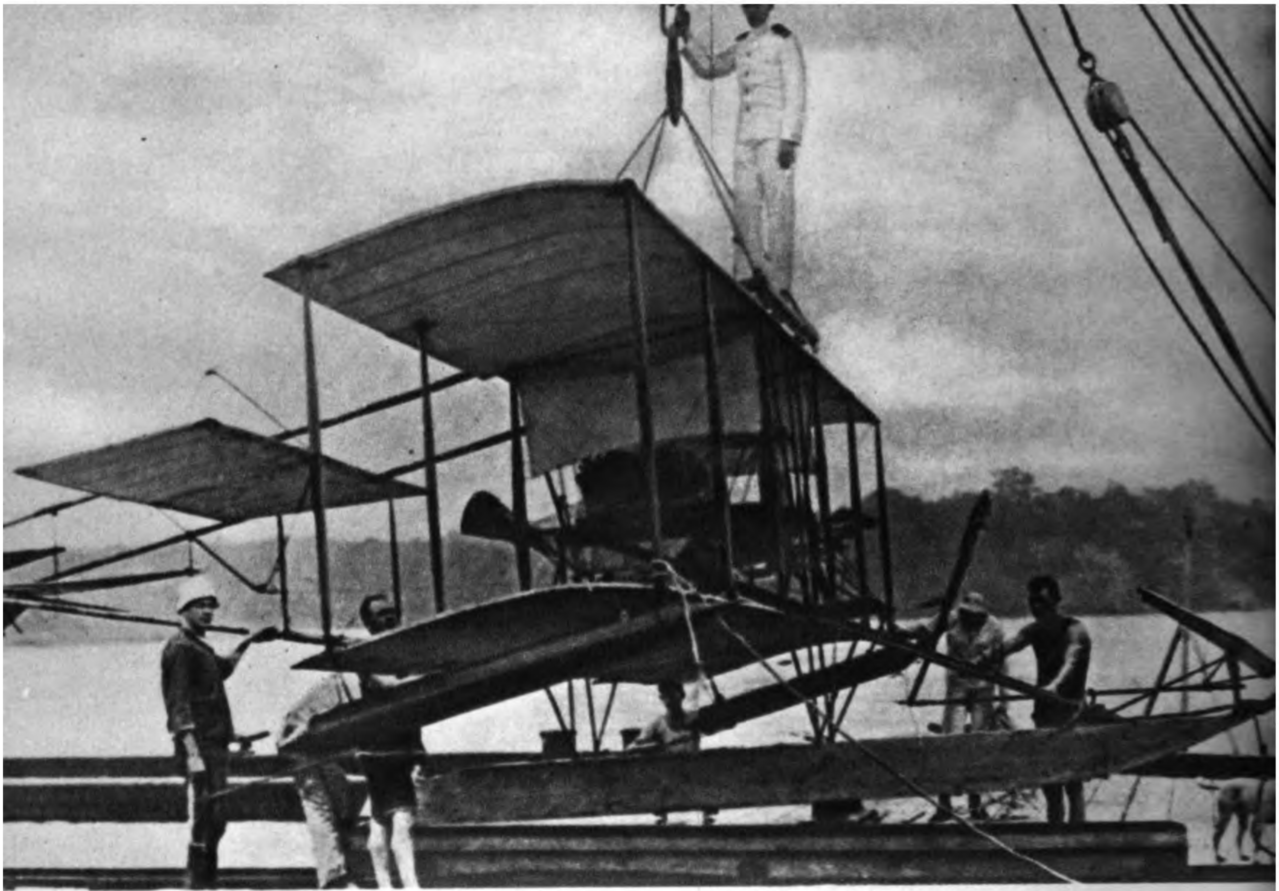
The development of ship-board launching devices



Earliest launching experiment. Lieutenant Ellyson made "tight-rope" take-offs with a Curtiss hydro at Hammondsport in 1912. The system proved impractical for ship installation and was quickly abandoned.

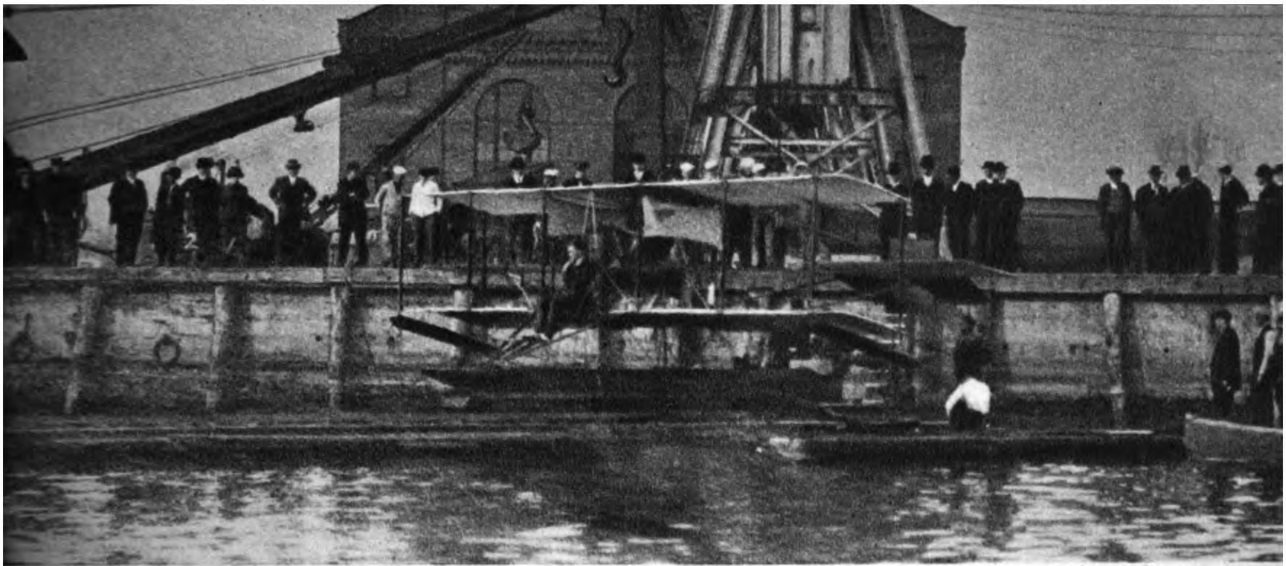


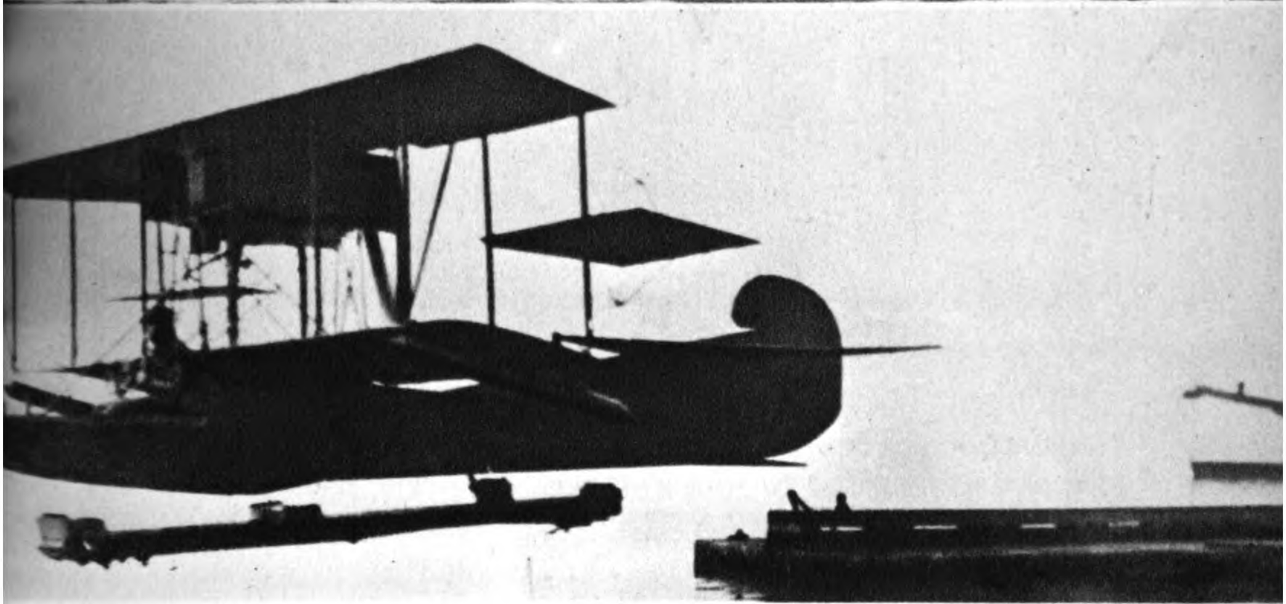
A shipboard launching experiment of 1919. A Sopwith scout (British) was launched experimentally from this turret-mounted platform on the *U.S.S. Texas*. Six experimental flights were made but this technique also proved impractical and was abandoned in favor of the power catapult and the aircraft carrier.

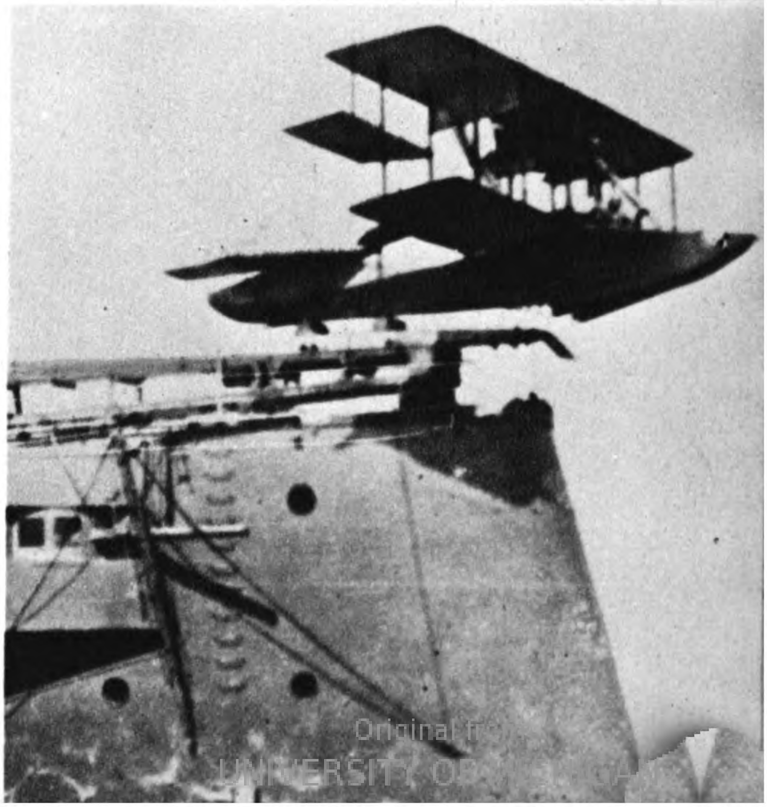


Ellyson's unsuccessful catapult attempt from the Santee Dock at Annapolis on July 31, 1912. The plane was wrecked but the pilot was unhurt.

FAILURE



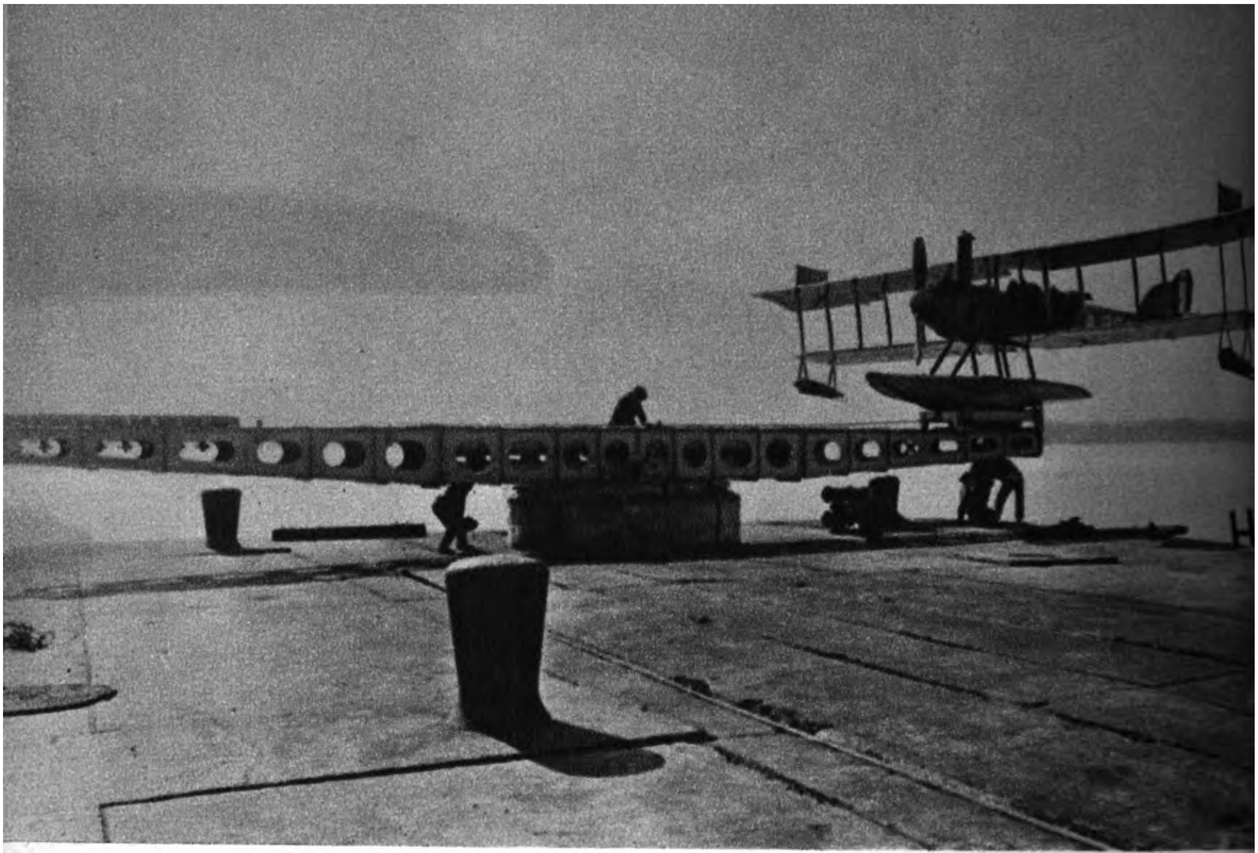




Top: Lieutenant Ellyson about to make the first successful catapult take-off, Washington Navy Yard, November 12, 1912.

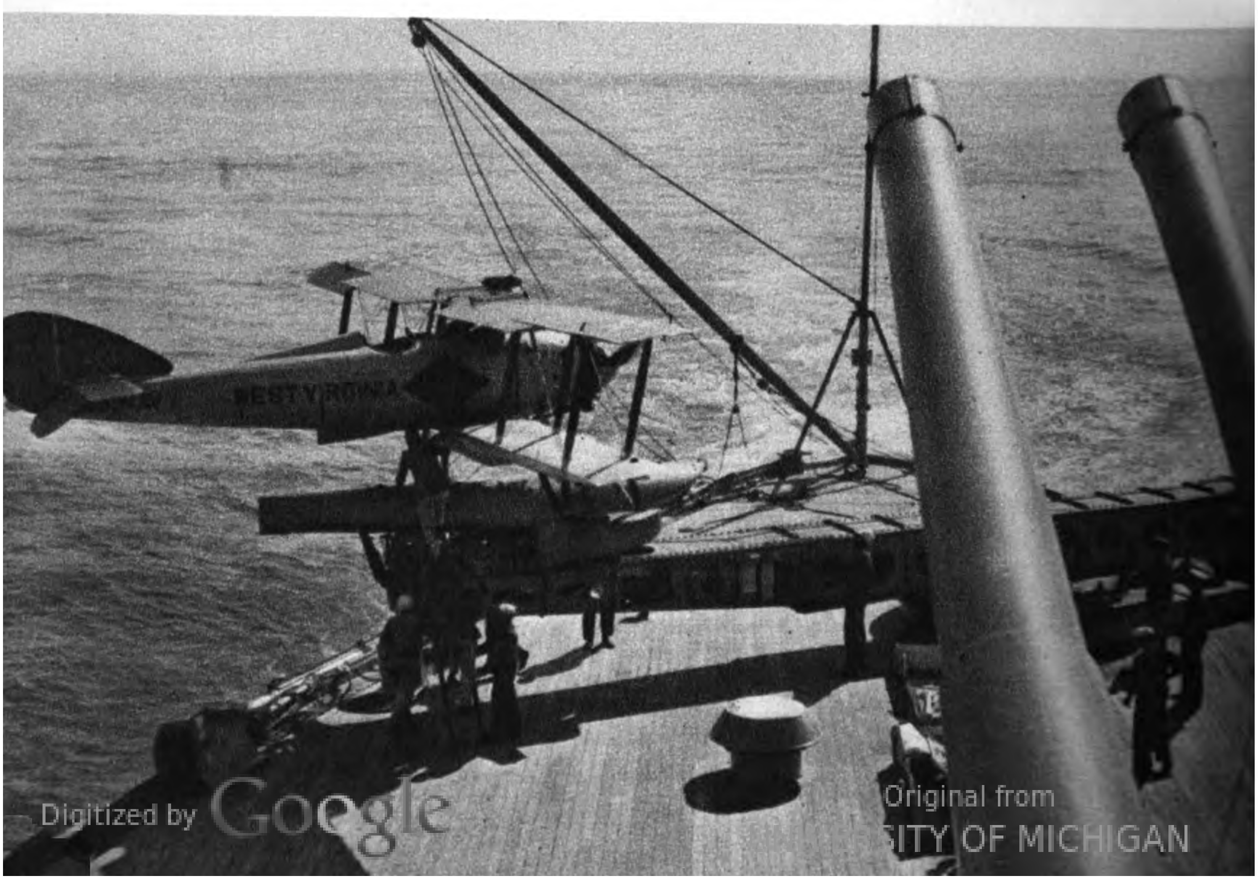
SUCCESS

Experimental catapulting of flying boats 1912-13. Above: At the Washington Navy Yard. Right: First launching from a Navy vessel.



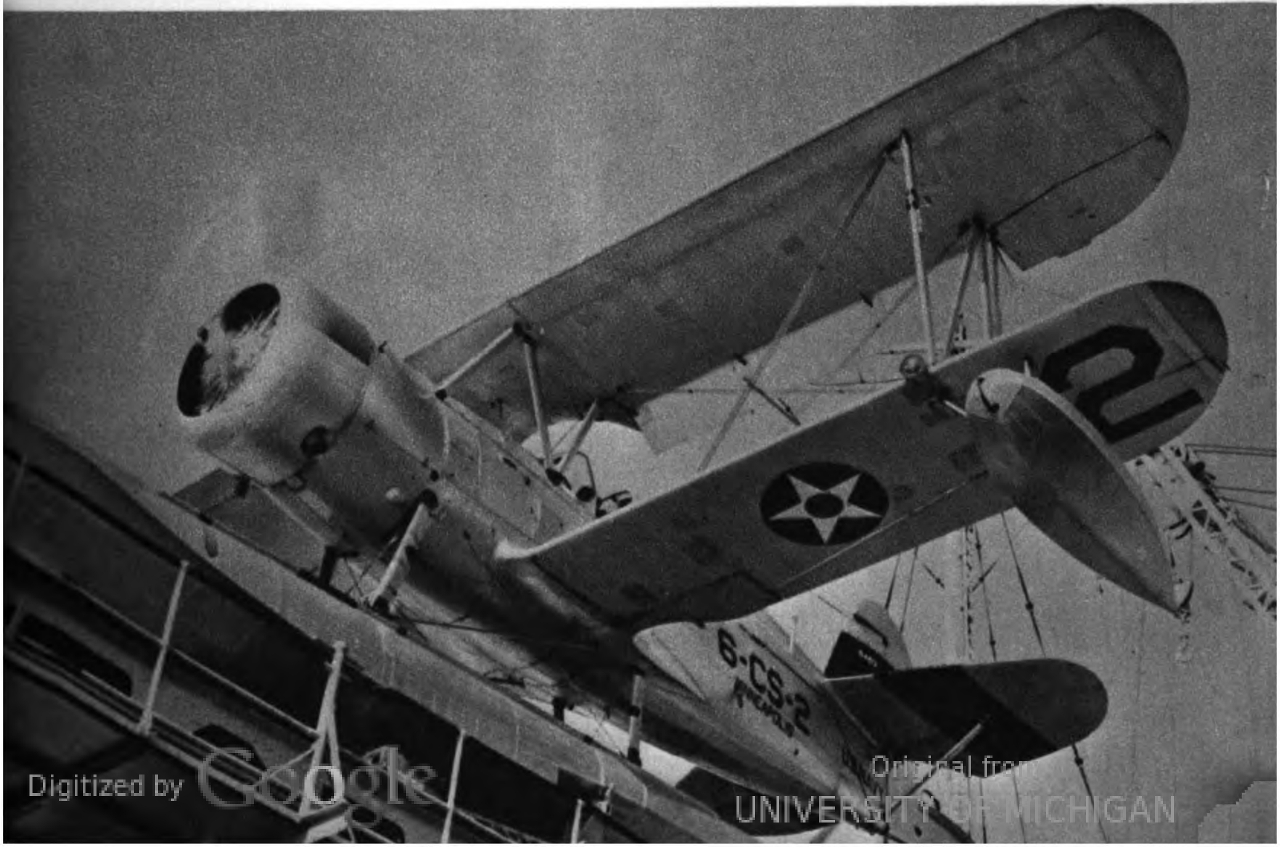
Turntable catapults were first installed and tested ashore.

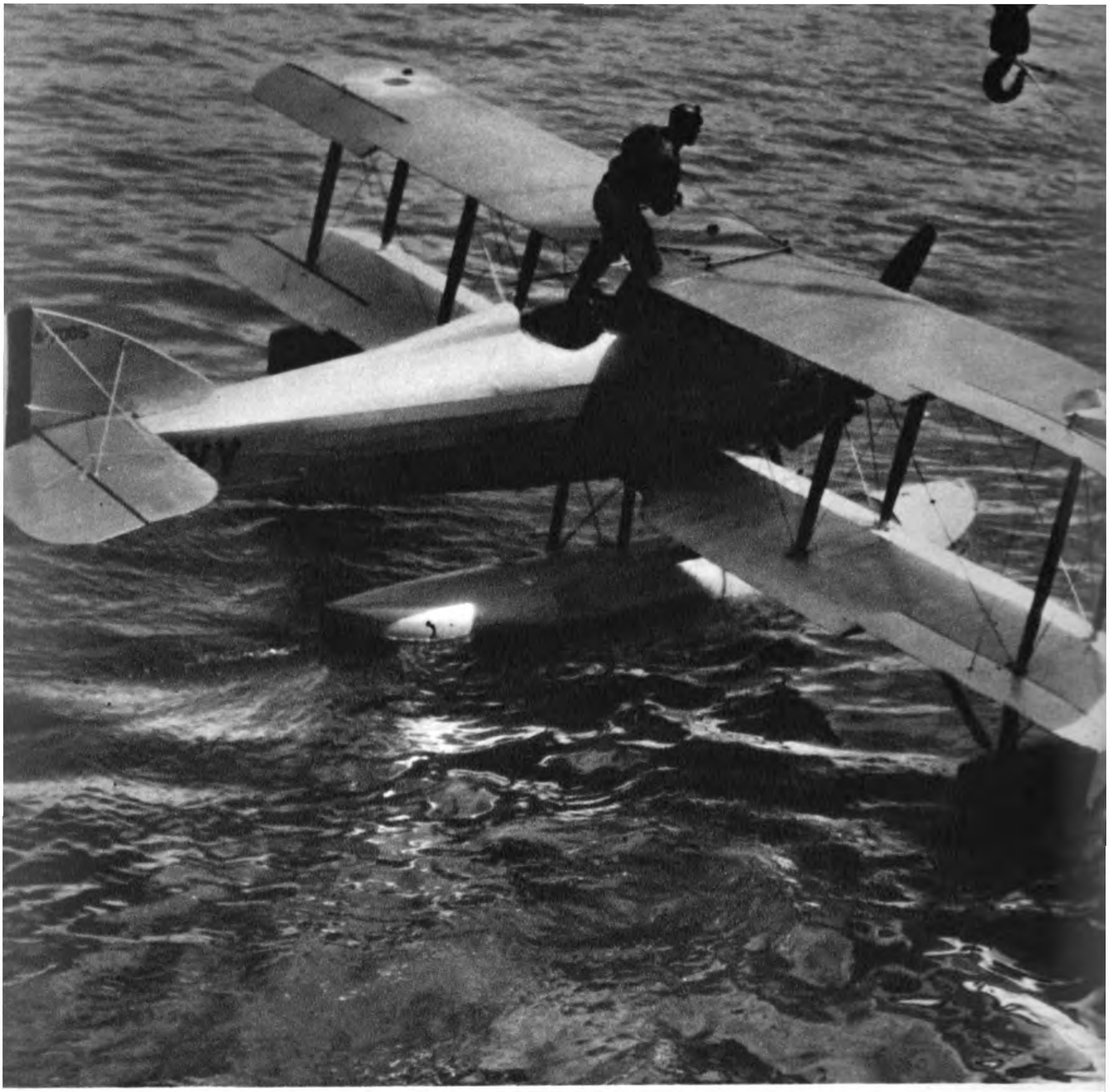
Navy announced in September 1919 that every American battleship was to be equipped with catapults. Preparing for a launching from the catapult on the quarterdeck of the *U.S.S. West Virginia.* (*Courtesy Underwood & Underwood*)



A Vought Corsair seaplane just off the end of the *U.S.S. Arkansas's* catapult.

Ready to fire, a Curtiss SOC-1 about to be launched from the *U.S.S. Minneapolis.*

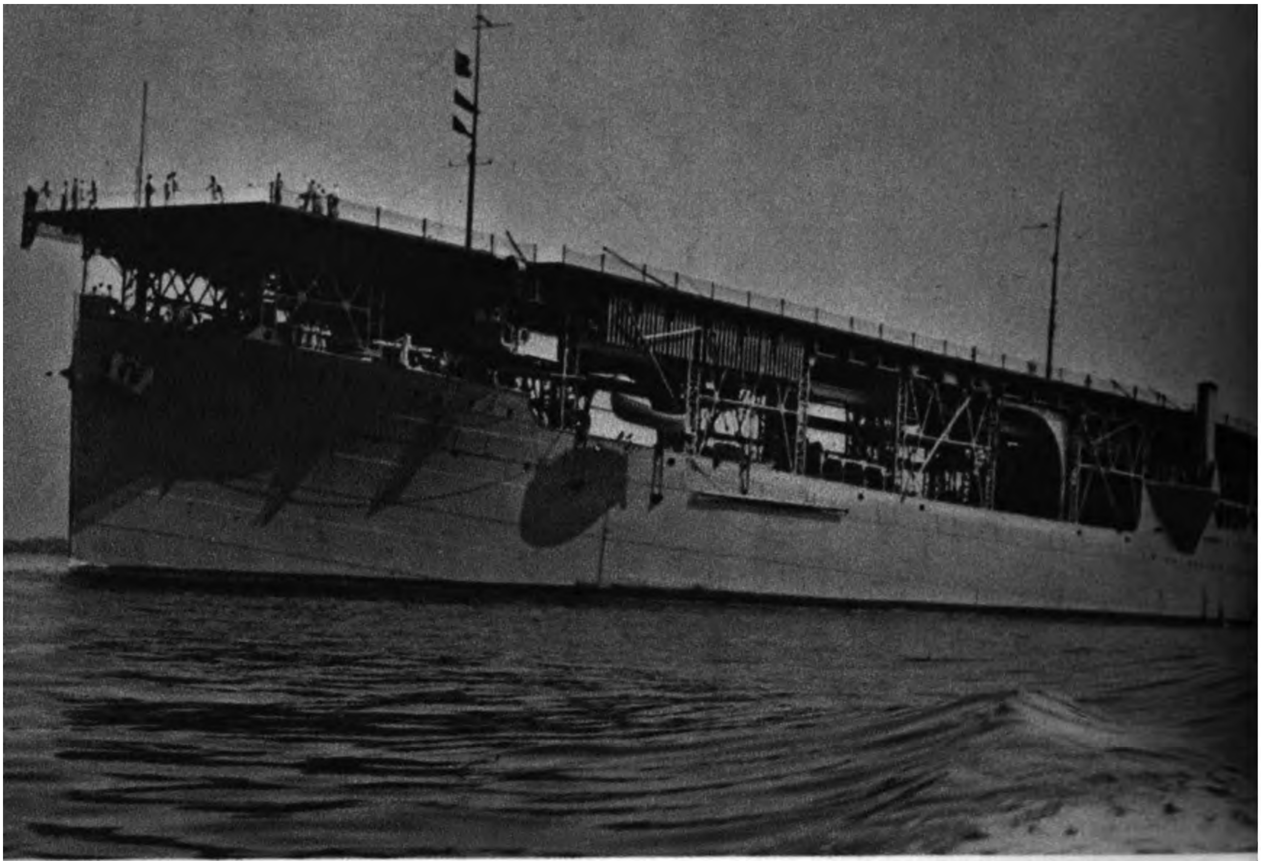




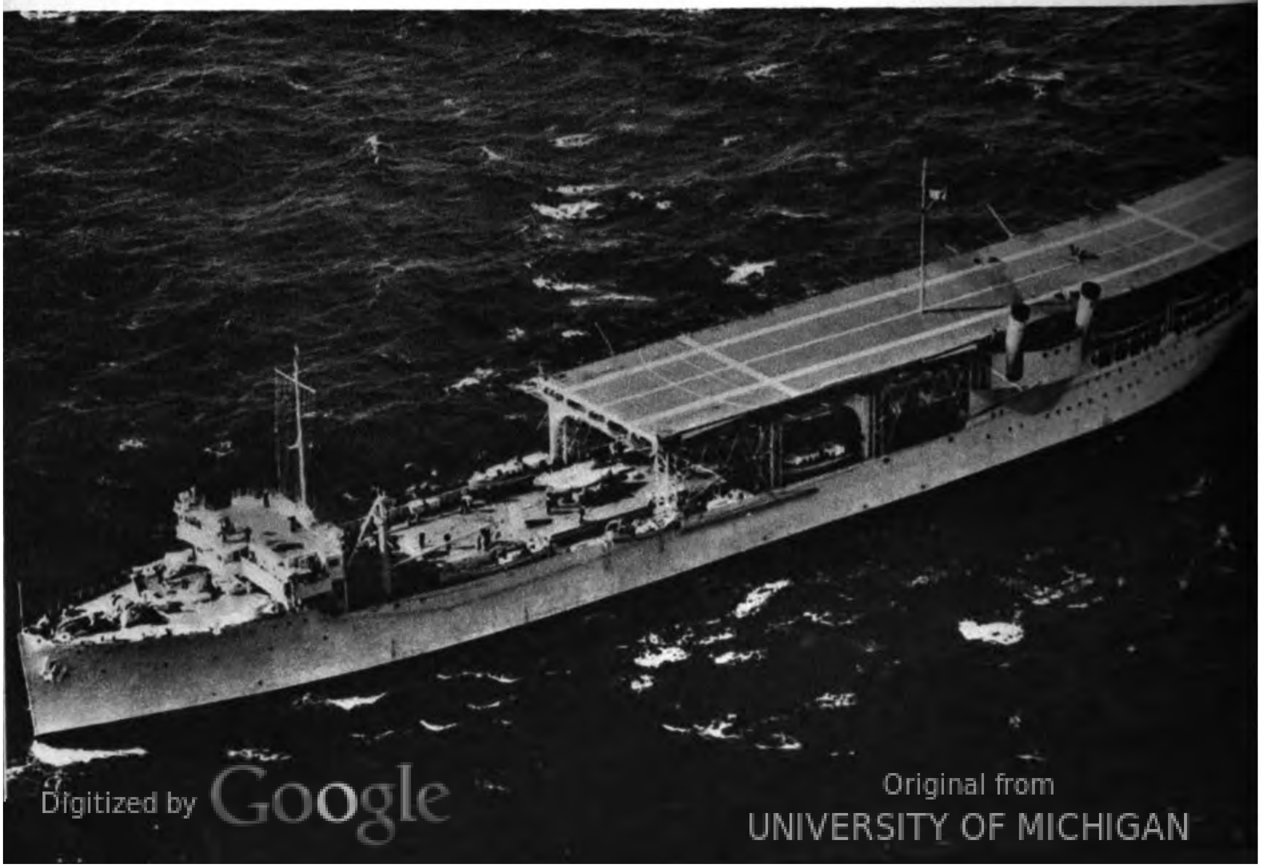
Catapult-launched seaplanes land alongside their ships and are hoisted aboard by crane. This picture was taken in June 1928, but the technique is the same today.

AIRCRAFT CARRIERS

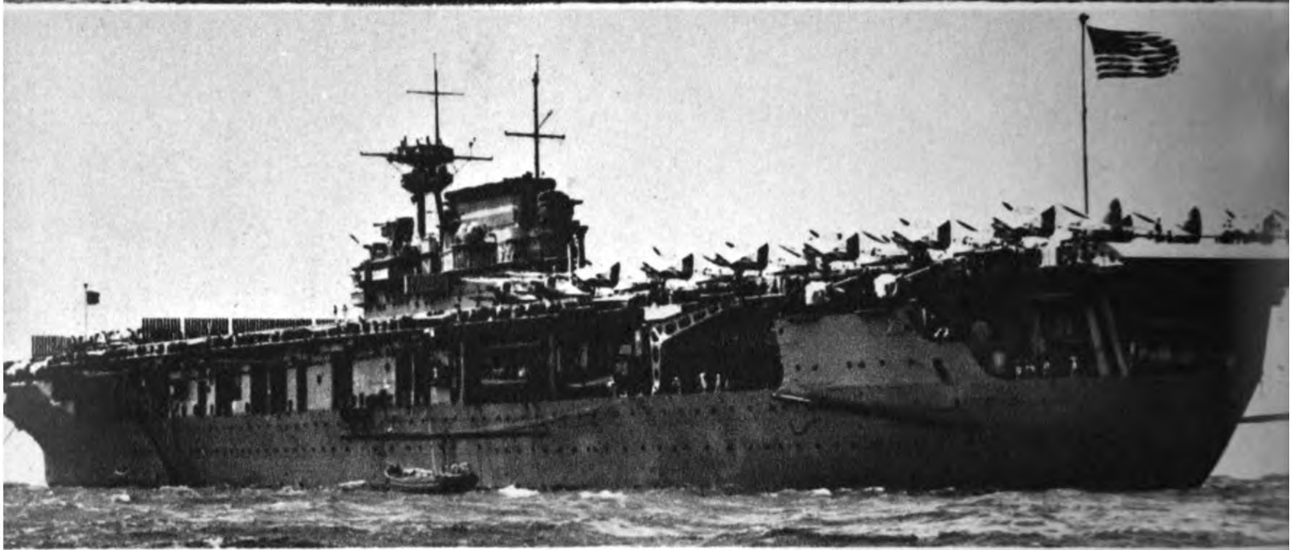
Floating airdromes that go to sea with the Fleets

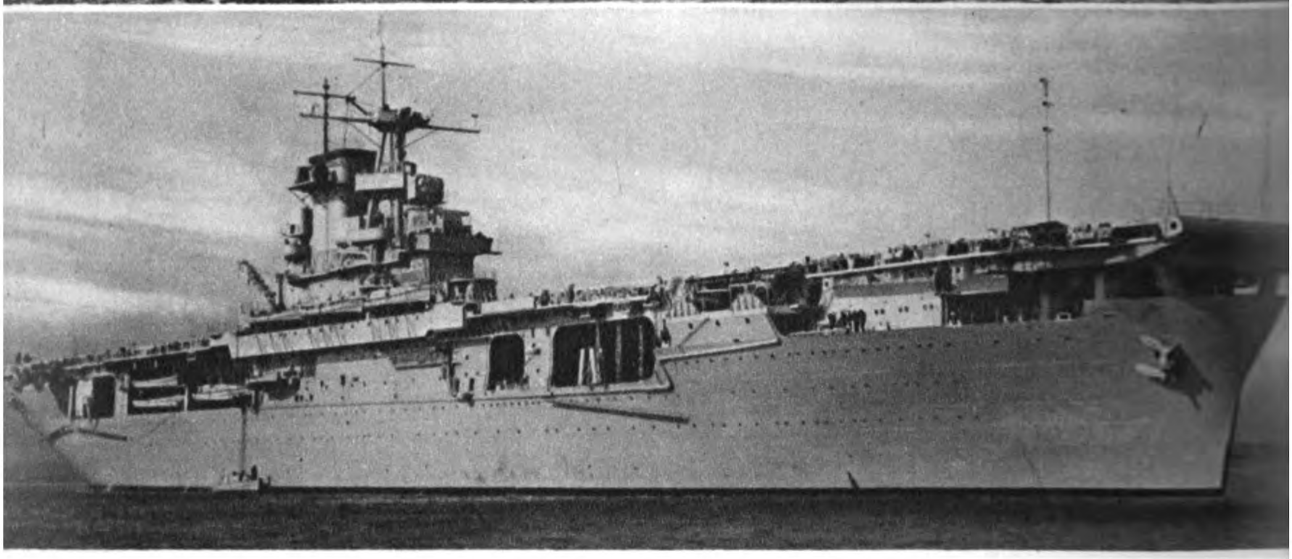


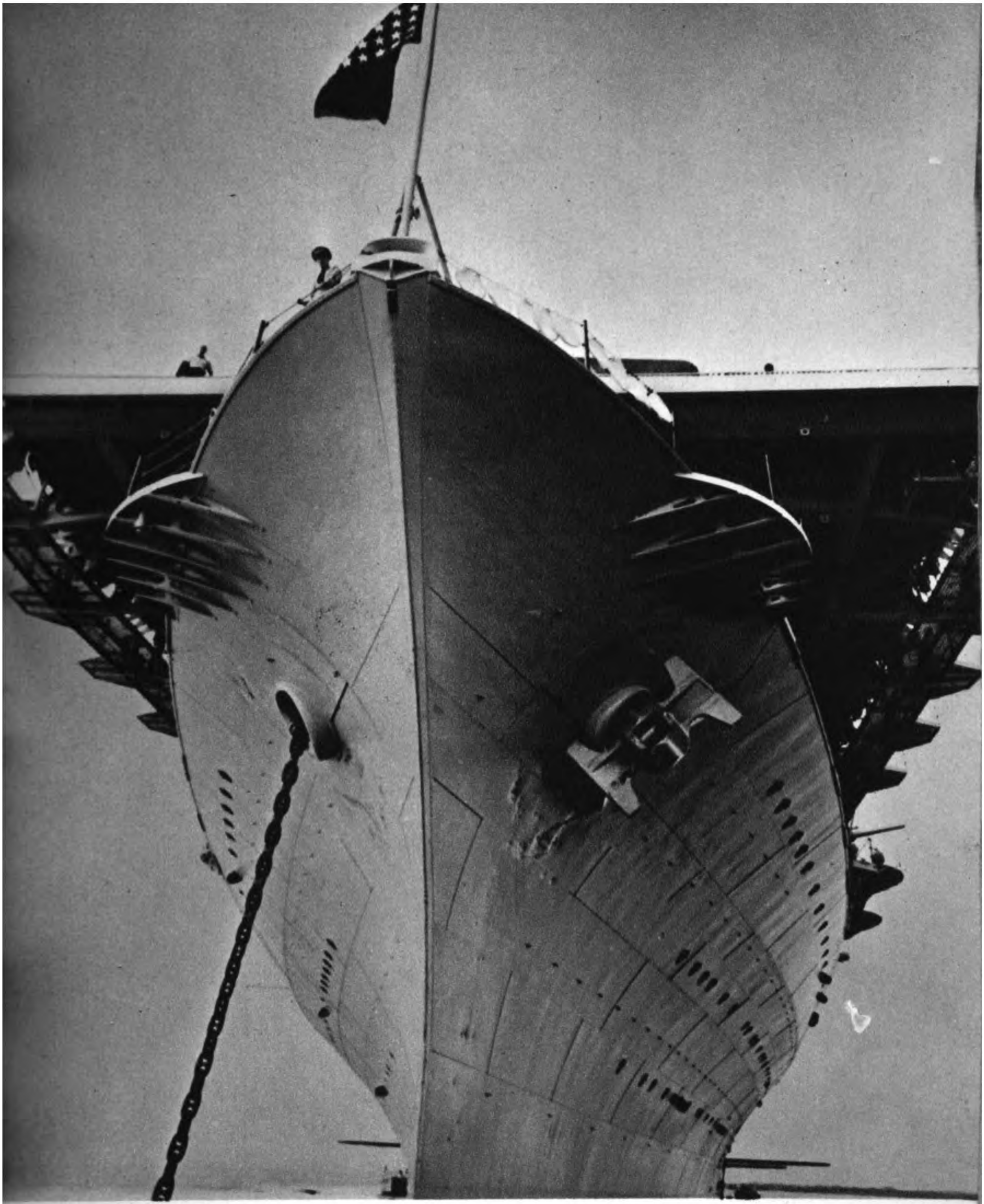
Collier to Carrier to Tender—a tabloid history of the *U.S.S. Langley* (nee *U.S.S. Jupiter*). She was the first aircraft carrier of the U.S. Navy. Many development projects were tested out on her flight deck. Today she is "mother ship" for a patrol squadron.



The *U.S.S. Saratoga* (above) and the *U.S.S. Lexington* (below) went into commission as aircraft carriers in 1927, joined the Fleet in 1928. They were originally laid down as heavy cruisers, were scheduled for scrapping under limitation of armaments agreements, were converted into carriers instead.







Parade of the floating airdromes. Opposite page (top to bottom): *U.S.S. Ranger, U.S.S. Enterprise, U.S.S. Wasp.* Above: Bow view of the *U.S.S. Ranger* at anchor in Guantanamo Bay.

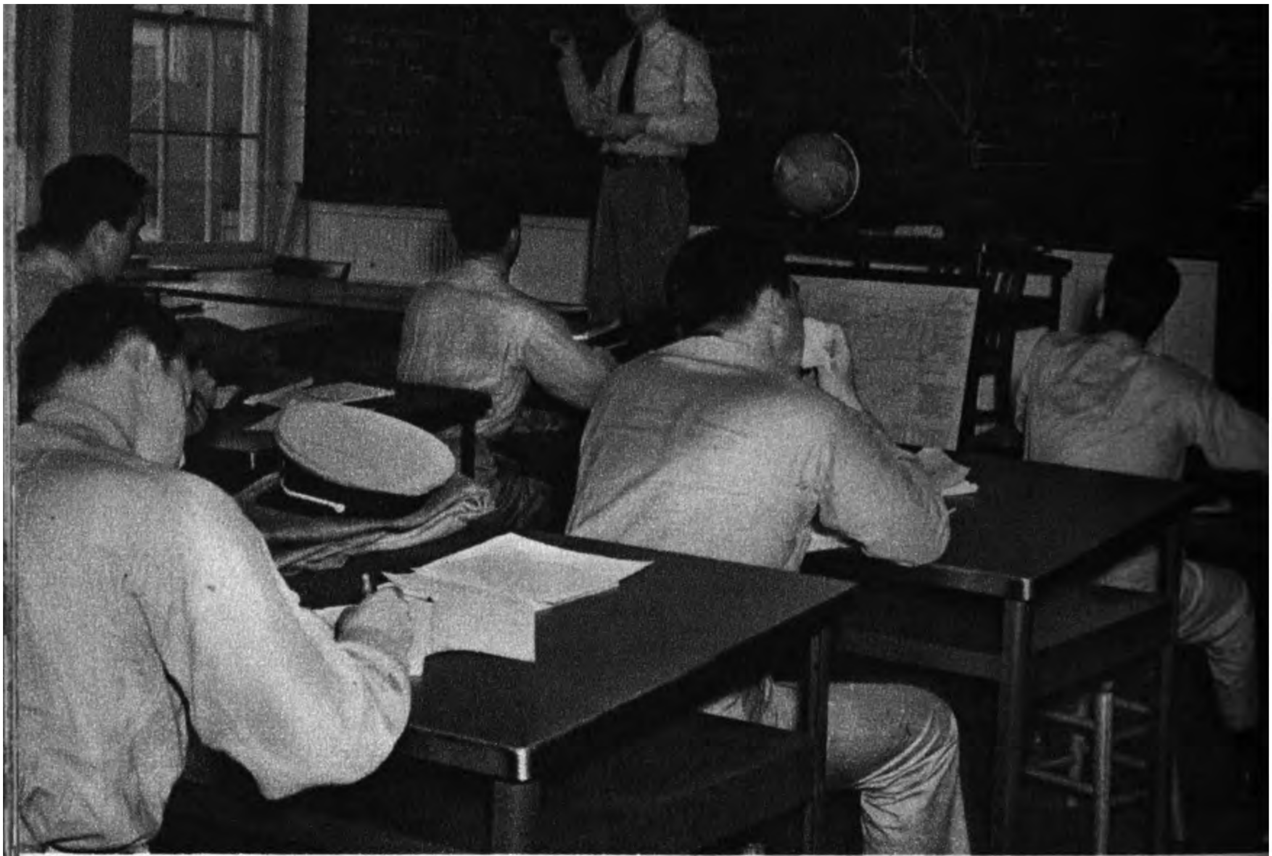
U.S.S. Saratoga, U.S.S. Lexington, and the airship tender *U.S.S. Patoka* as viewed from the *U.S.S. Los Angeles* circa 1930.

TRAINING AND TRAINERS

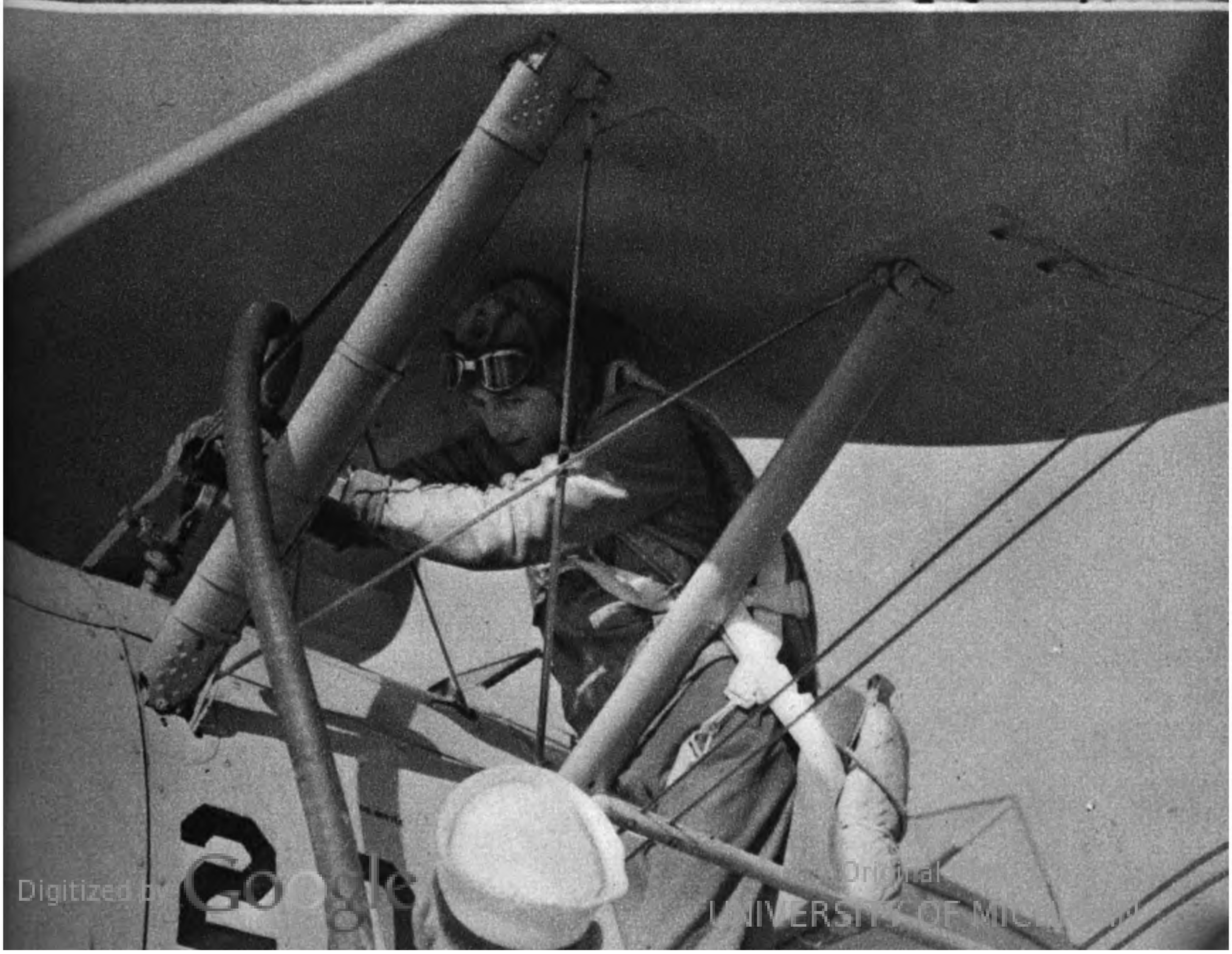
A quick survey of the men, machines and methods used
to train the pilots for U.S. Flying Fleets

On the beach at Pensacola, then and now. Above: Line-up of hydros and tent hangars in March 1914. Below: Same location, 25 years later.

Navy pilots must learn to fly from land as well as water. Corry Field is the headquarters for Squadron 2 at Pensacola. Line-up of NS-1's.



A day in the life of a Naval flying cadet. Above: A classroom exercise in navigation. Below: A work-out on the Link trainer (The cadet is "under the hood" in the airplane-like gadget in the background. The instructor is talking to him through the microphone). (Opposite page) Above: Instructional map reading before take-off. Below: A cadet pilot gassing-up his plane after a cross-country hop.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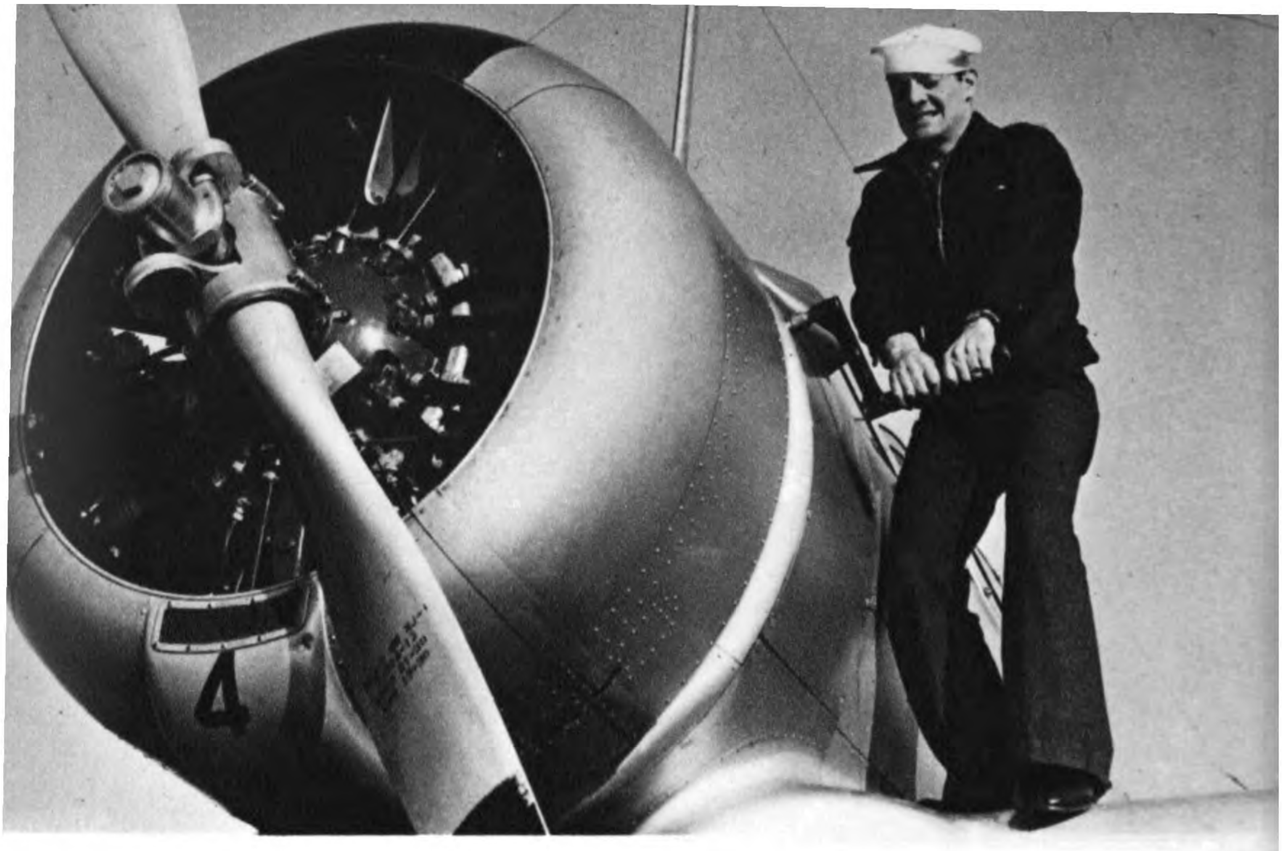
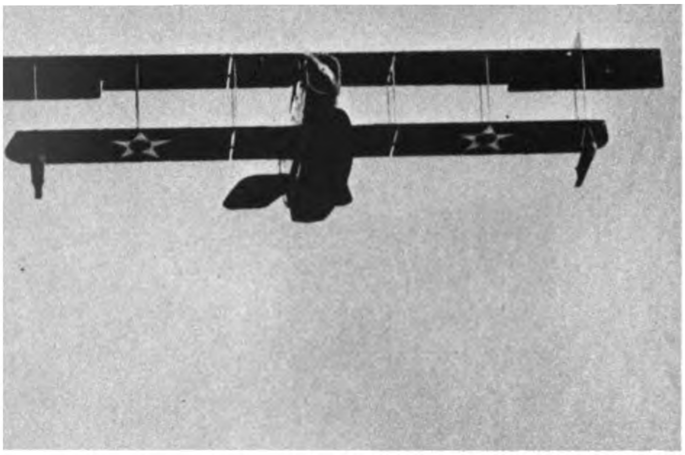


Naval ground crews keep training airplanes in first class flying condition at Pensacola. Safety depends on good maintenance.

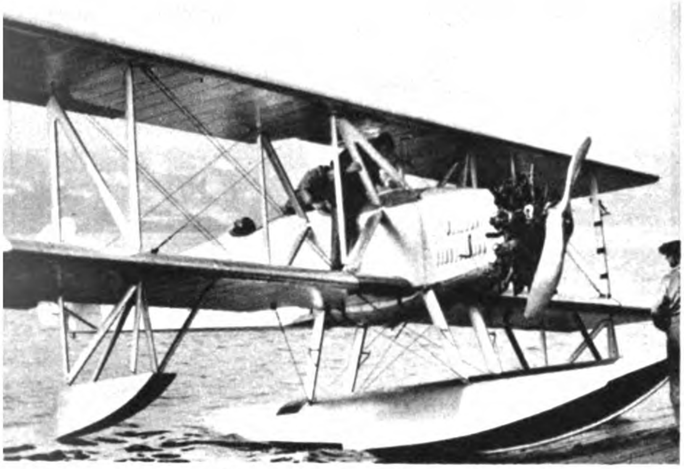
shion plate for U.S. Naval flying dets. Seat-pack parachutes are used. ubes attached to helmet are for communication with instructor.

"up-check"—a study in expres- s. Another student graduates to adron Two.

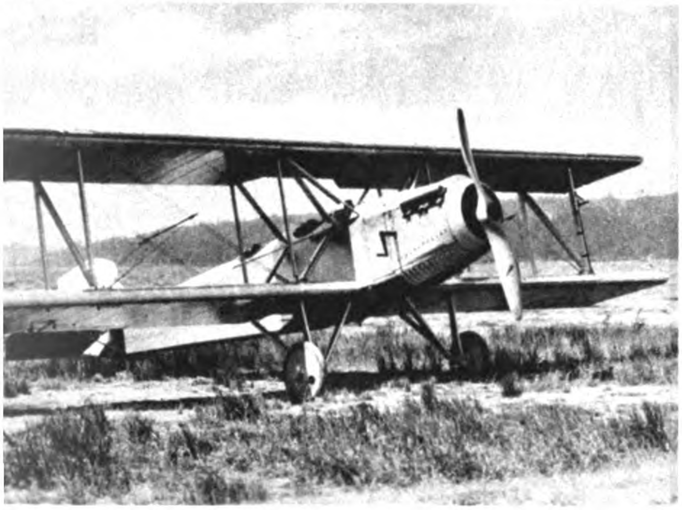
TRAINERS, THEN AND NOW



The Curtiss N-9 trainer of 1918. (*Courtesy Aviation Magazine*)



Boeing built the VNB-1 trainer in 1923. It was powered with a Lawrence J-1 engine. (*Courtesy Boeing Airplane Company*)

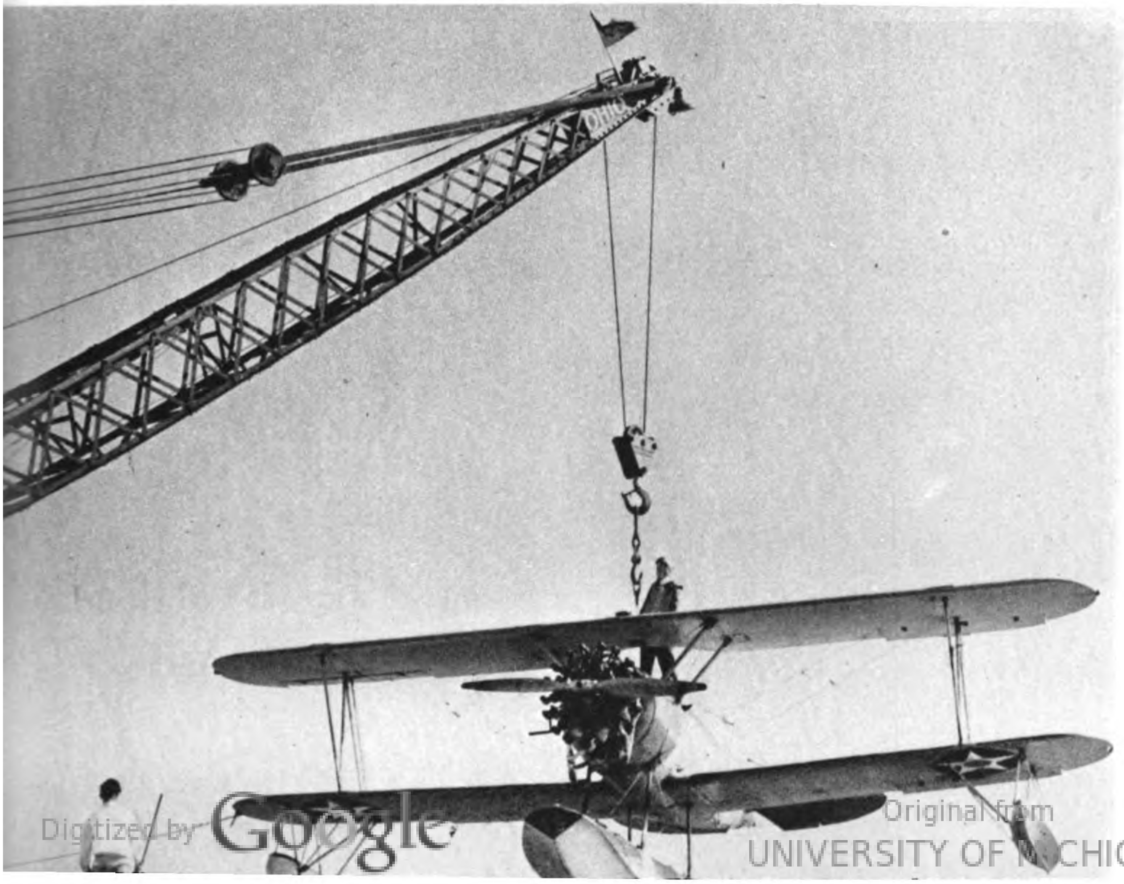


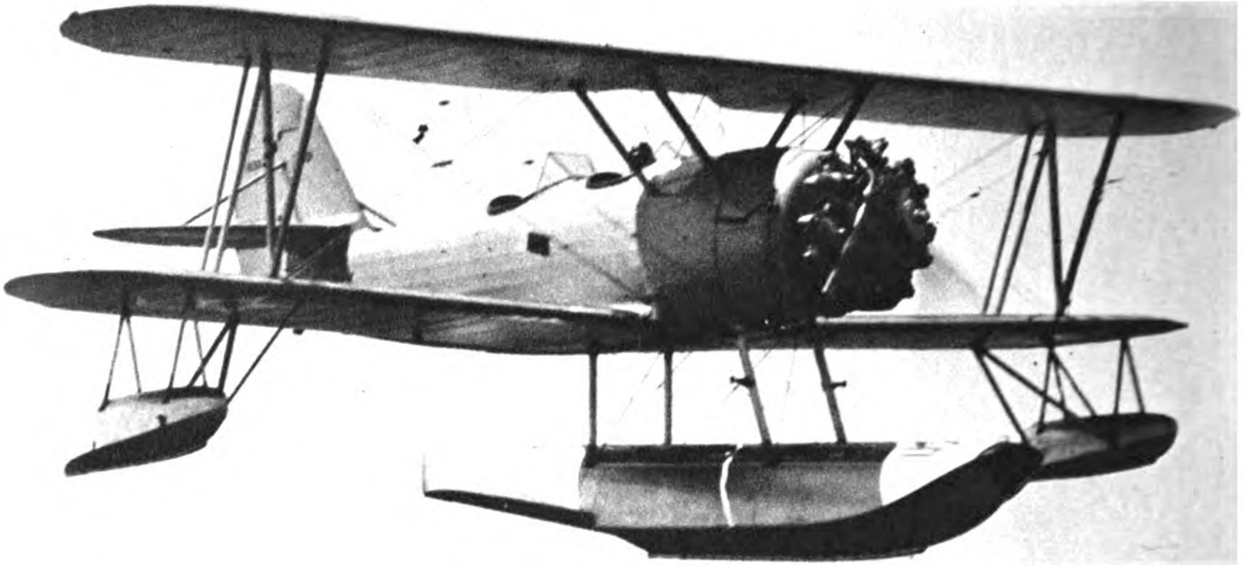
A later Boeing trainer, one of thirty NB-2's delivered to the Navy in 1924 and 1925. (*Courtesy Boeing Airplane Company*)

Between 1925 and 1930 the Consolidated NY-1 trainer was widely used by the Navy.

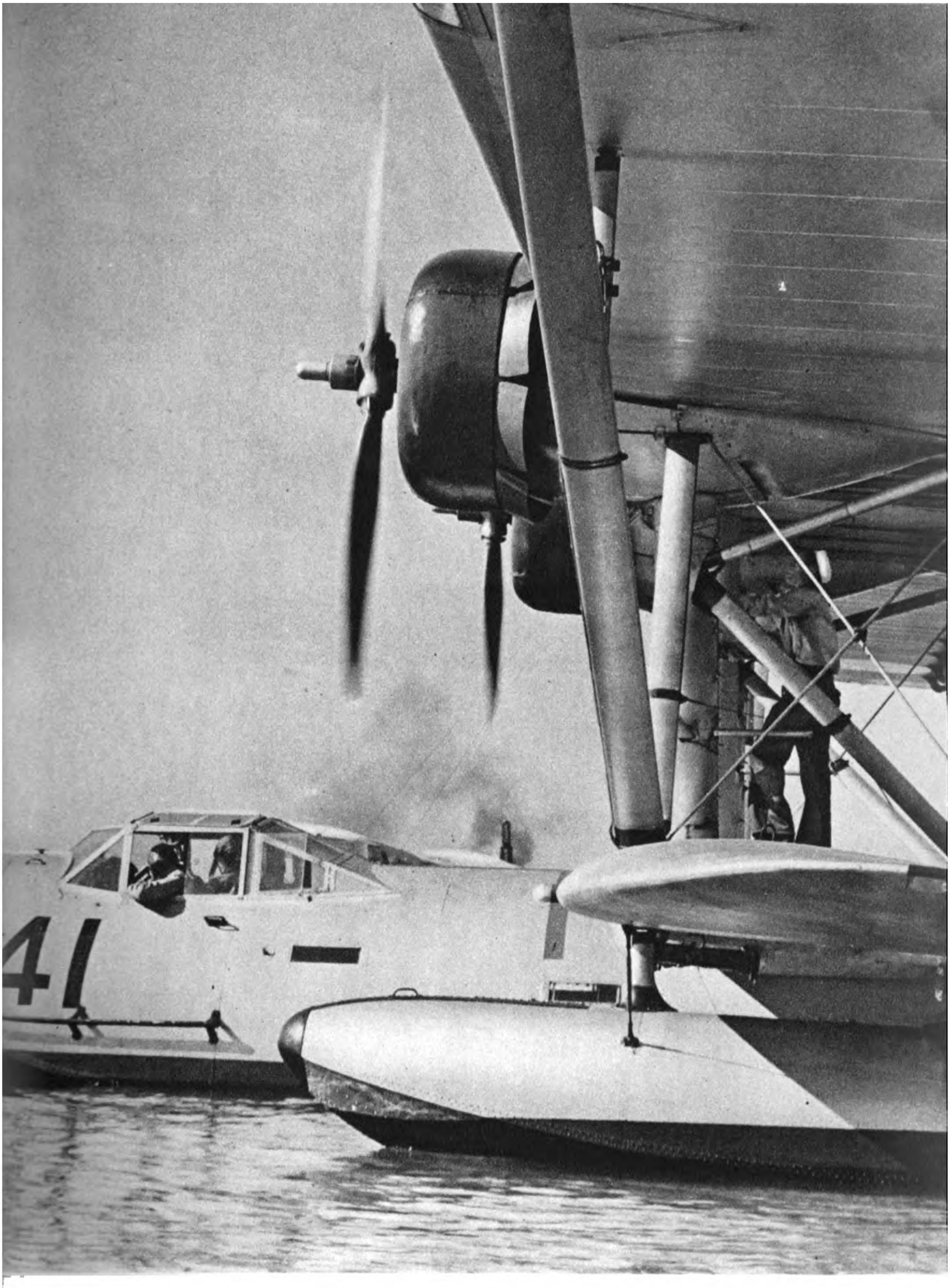
The NY-1 was also used as a seaplane for student instruction (1927).

Students at Pensacola learn how to handle seaplanes on cranes in anticipation of shipboard service.

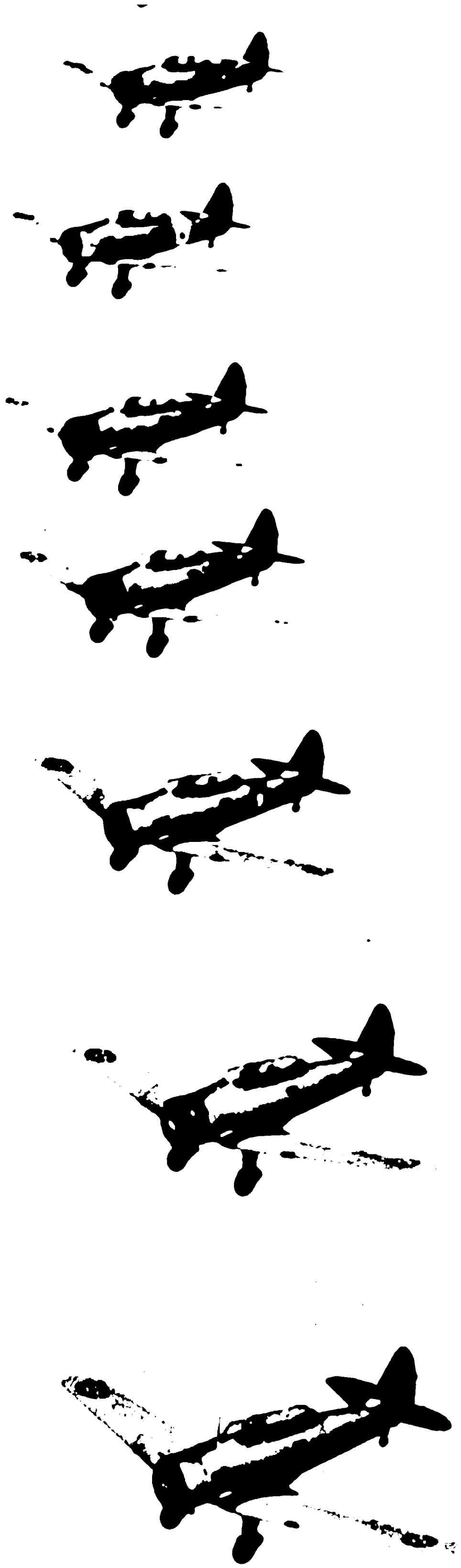




A pair of modern Navy trainers. Above: The N3N-3 as a seaplane. Below: The North American NJ-1 is used in the secondary training stages for deck landings, etc.



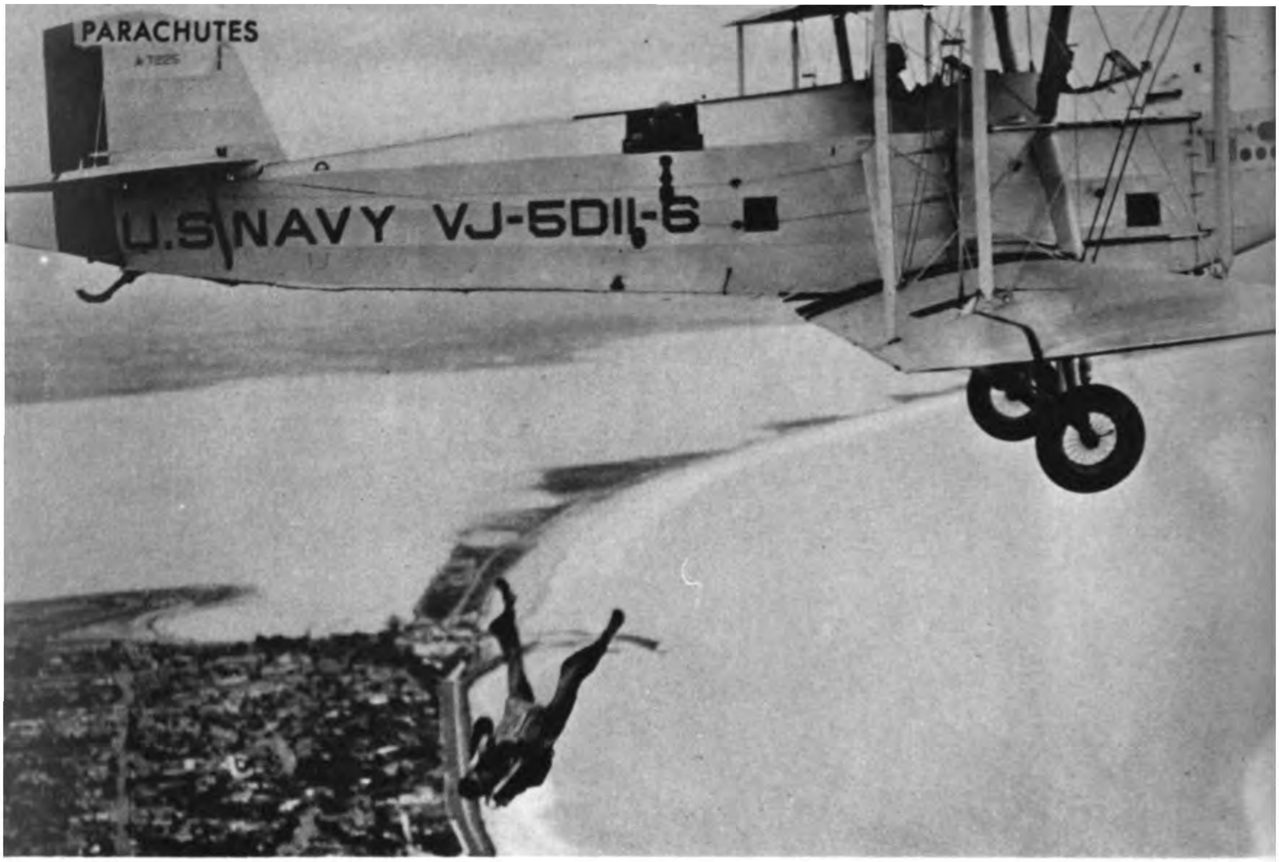
Patrol planes that have become obsolete for service use are assigned to Pensacola for training advanced students in handling big boats.



A squadron of NJ-1 trainers in echelon. Formation flying is an essential part of t
curriculum for Naval flying cadets.

PARACHUTES

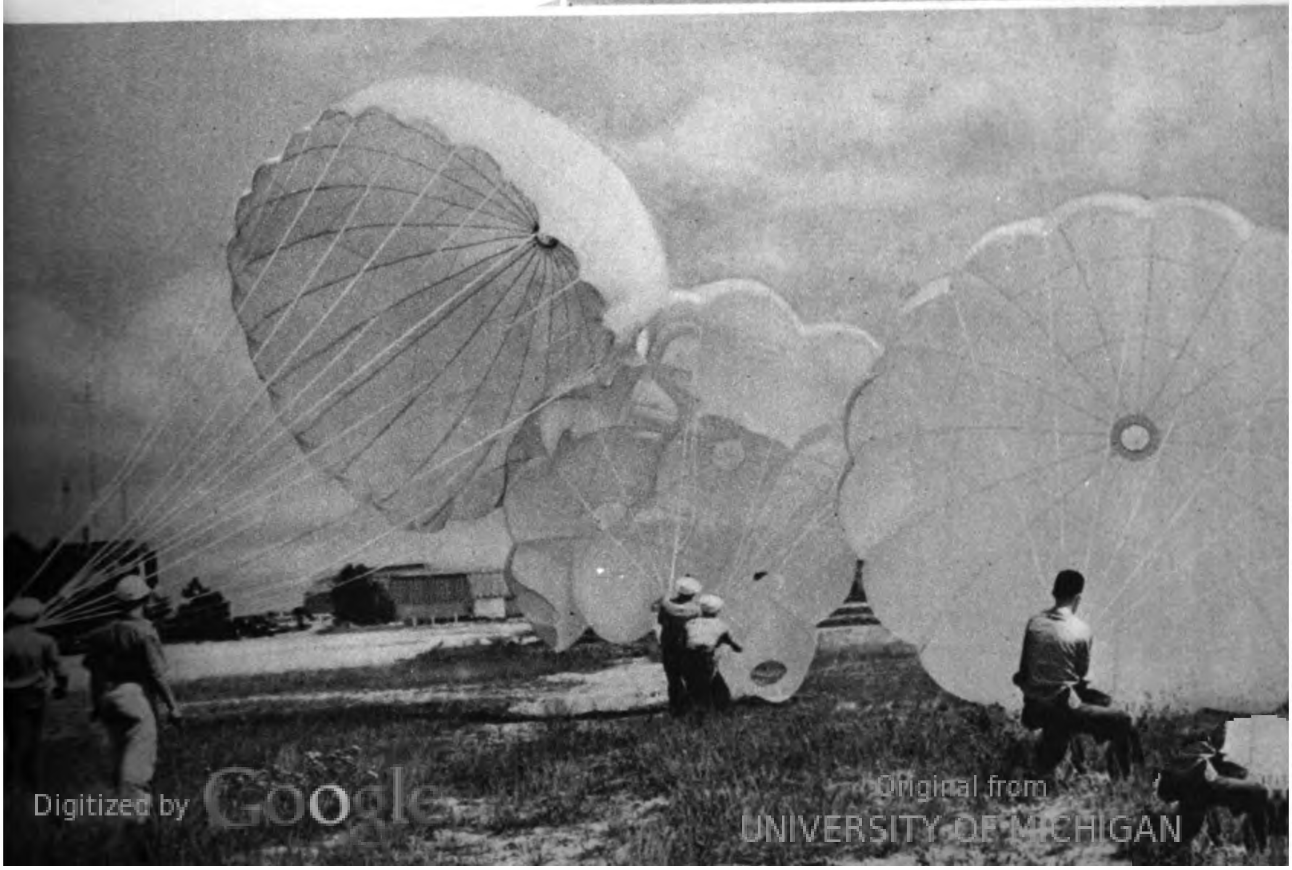
Originally an aerial life saver—now a potential tactical weapon



Two methods of leaving an airplane by parachute. Above: A free drop in which the chute is opened after leaving the plane. Below: A pull-off in which the ripcord is pulled while the parachutist is still standing on the wing of the airplane. This method is seldom used today. (These pictures were taken about 1925)

The seat-pack parachute is the most commonly used in the Navy today. The ripcord is attached to the square wire handle just above the pilot's left forearm.

Ground testing several types of canopy. Parachutes are generally made of the best grade of Japanese silk obtainable. In view of possible shortages, nylon and other materials are now being tried as substitutes.



Students at the Navy's parachute school at Lakehurst must make "live" jumps before graduation. Above: A parachute class goes aboard a K-2 blimp. Two parachutes, one back-pack and one chest-pack, are worn for safety. Opposite page, top: First stage of a jump seen from above. The pilot chute is pulling the main canopy out of the pack. Bottom: With the main chute open the student drifts down toward the landing field.

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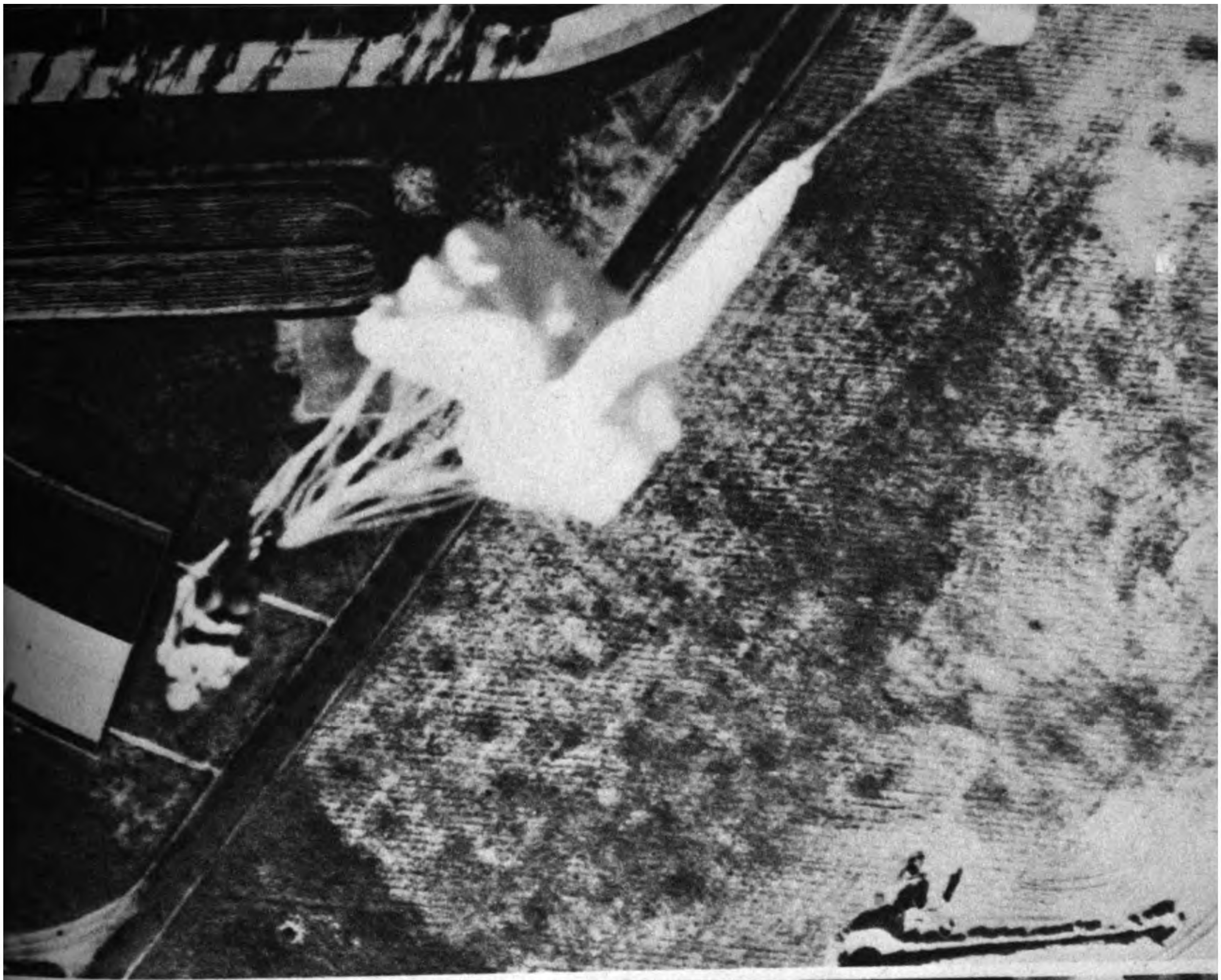
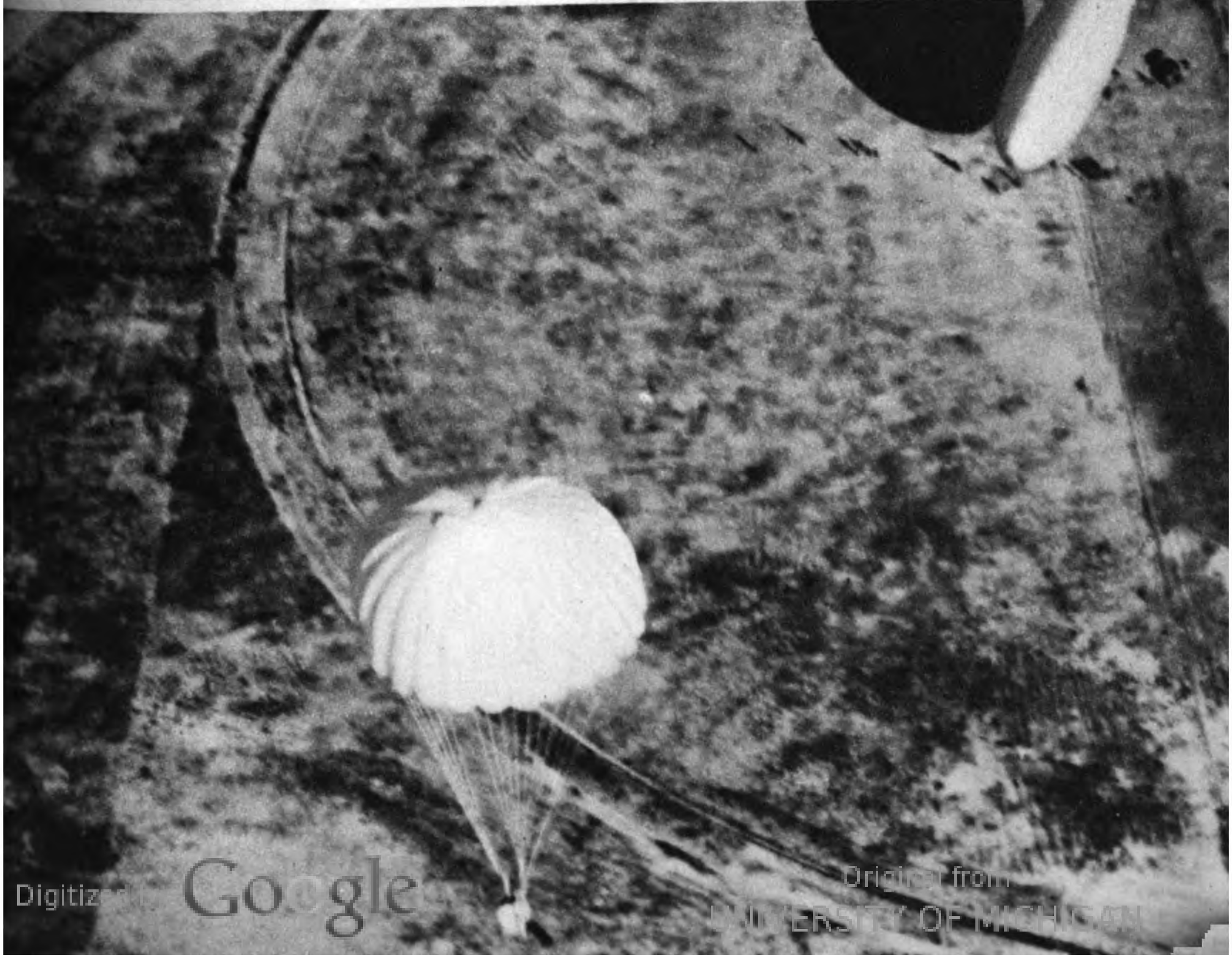
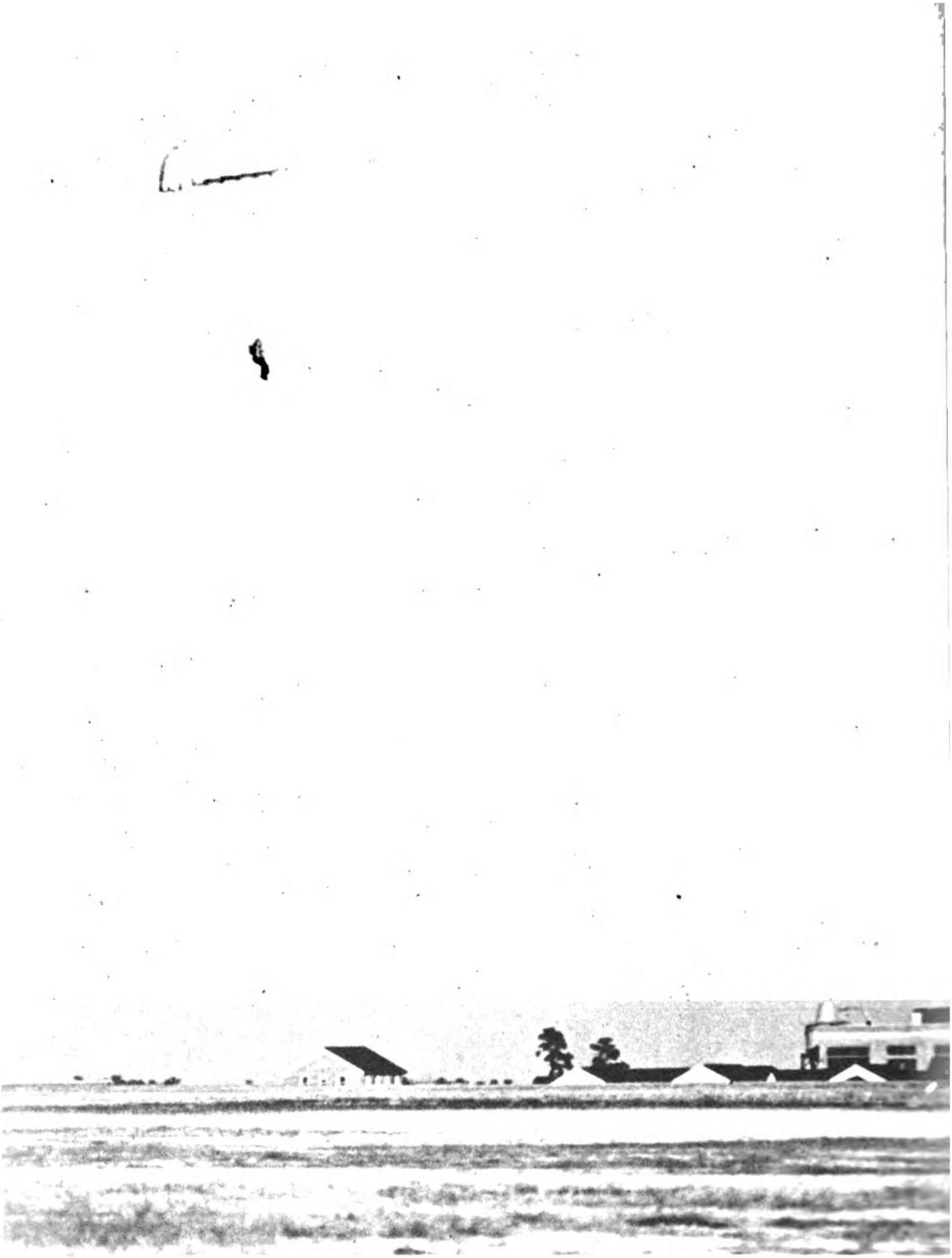






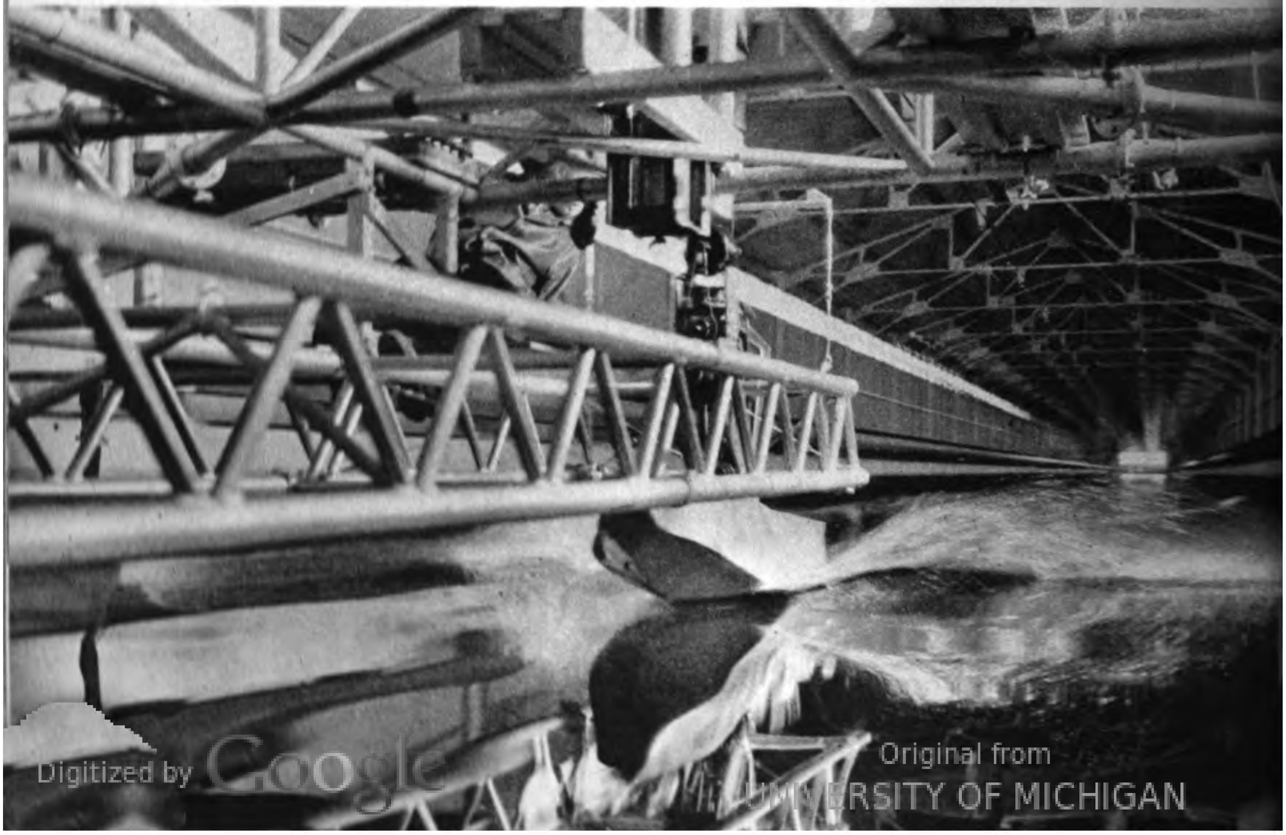
About to land from a parachute jump. Impact with the ground is about the same as that of jumping from a 12-foot fence.

MANUFACTURING

The pictures in the following section have been made available by the Glenn L. Martin Company to illustrate the processes of manufacture of a typical naval airplane—in this case, the PBM patrol bomber.

DESIGN. Many thousands of man hours are put in over drafting boards in laying out the plans and details for a big flying boat.

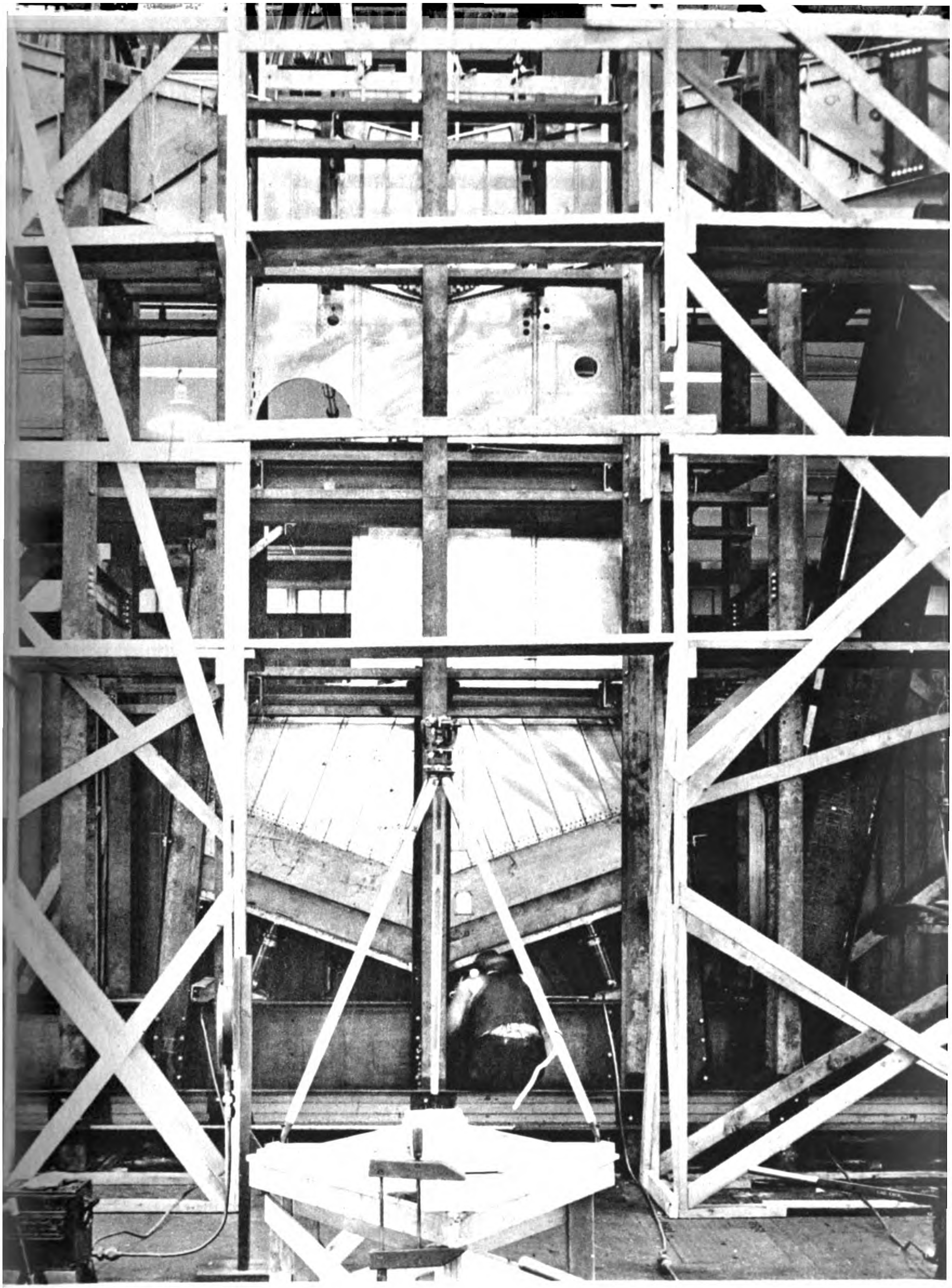
MODEL TESTING. The behavior of a flying boat hull can be predicted from checking models in towing basins. Here is a test being run off in the 2,000 foot towing basin of the National Advisory Committee for Aeronautics at Langley Field.



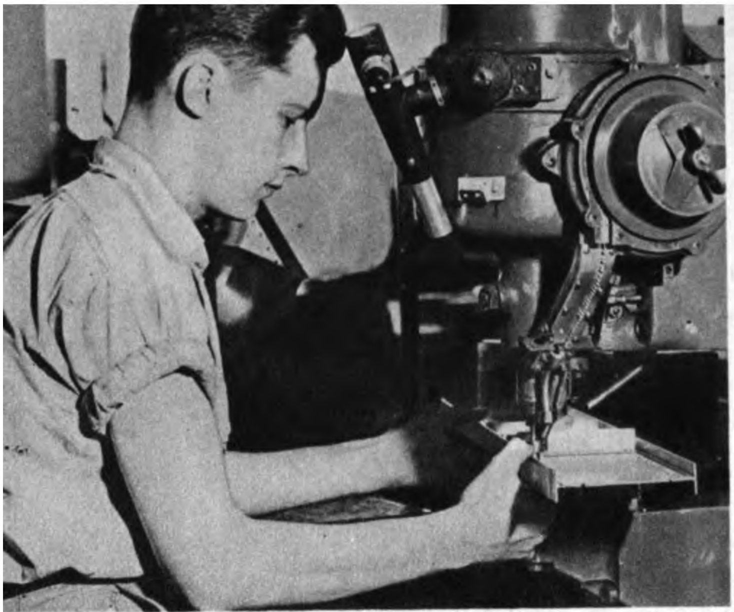
MOCK-UP. Before releasing parts for manufacture a full-scale dummy of the airplane is built up out of wood and cloth and paper to make certain that all parts are properly arranged. This is the cockpit of the PBM mock-up.

MATERIALS TESTING. All parts and materials that go into Navy flying boats are carefully checked in chemical and physical laboratories.

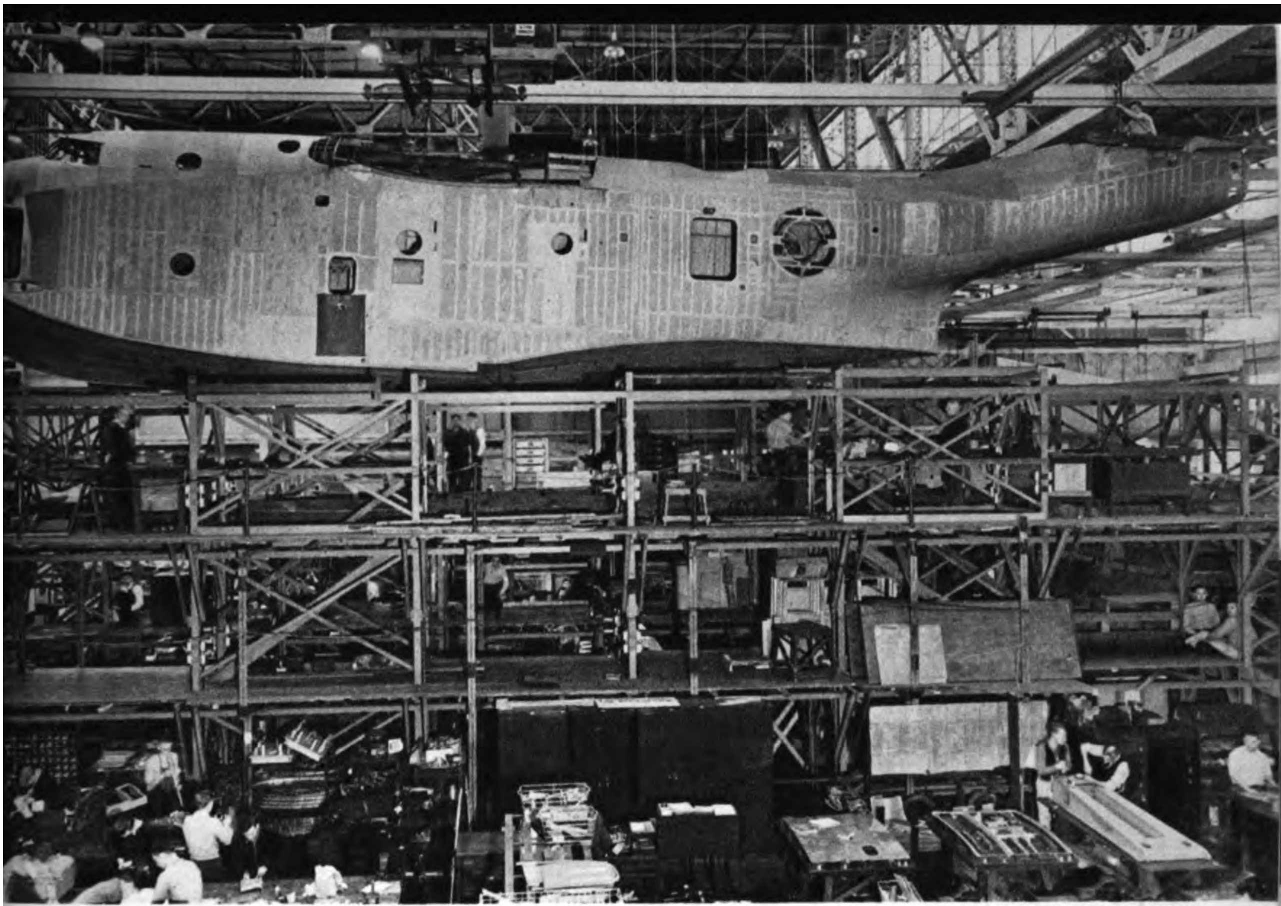
MATERIA
carefully che



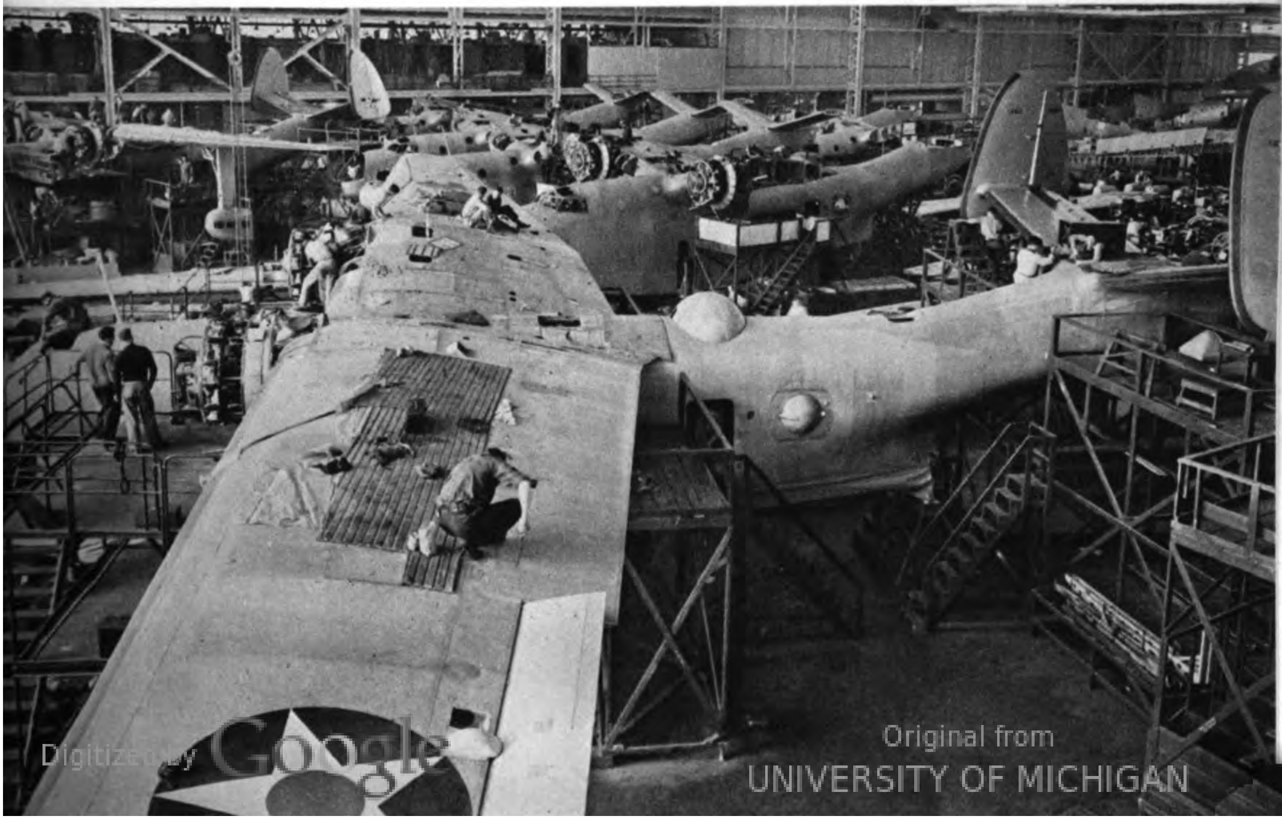
STRUCTURES TESTING. Before being put into final assemblies full-sized sections of wings and hull are tested to destruction to check designers' computations.

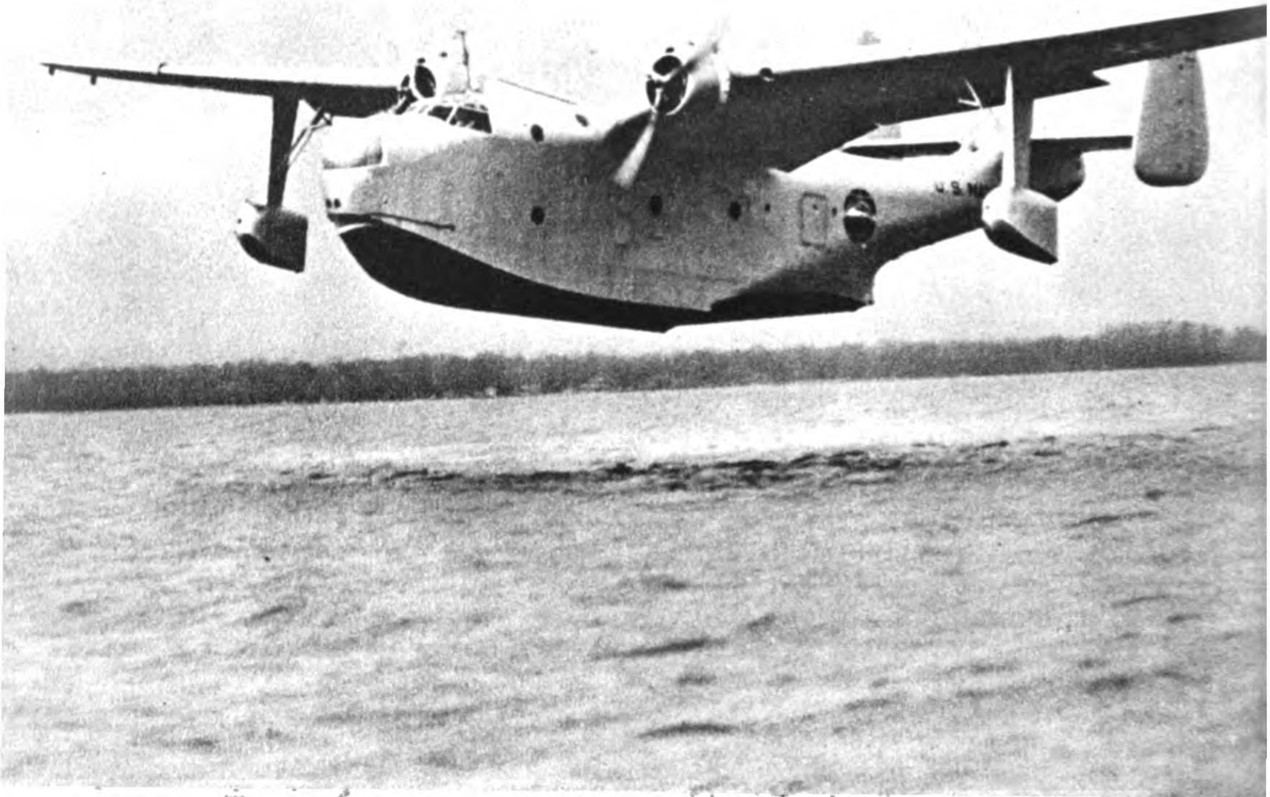


PARTS AND SUB-ASSEMBLIES. After checking and testing the design drawings are released to the shop for the manufacture of the thousands of separate parts that go into the completed flying boat.



FINAL ASSEMBLY. Above: The completed hull is lifted bodily out of the jig in which it has been built. Below: Wings, tail surfaces, and engine nacelles are mounted in the final assembly department.





FLIGHT TESTING. After extended series of tests on the ground to determine the proper functioning of all parts, the finished airplane takes to the air on its first test hop.